CHEMICAL & METALLURGICAL ENGINEERING

w York, Sept. 24, 1918 McGraw-Hill Company, Inc. Vol. XIX, No. 6a 25c a copy

THE WESTPORT MILL

Laboratory and Testing Plant of

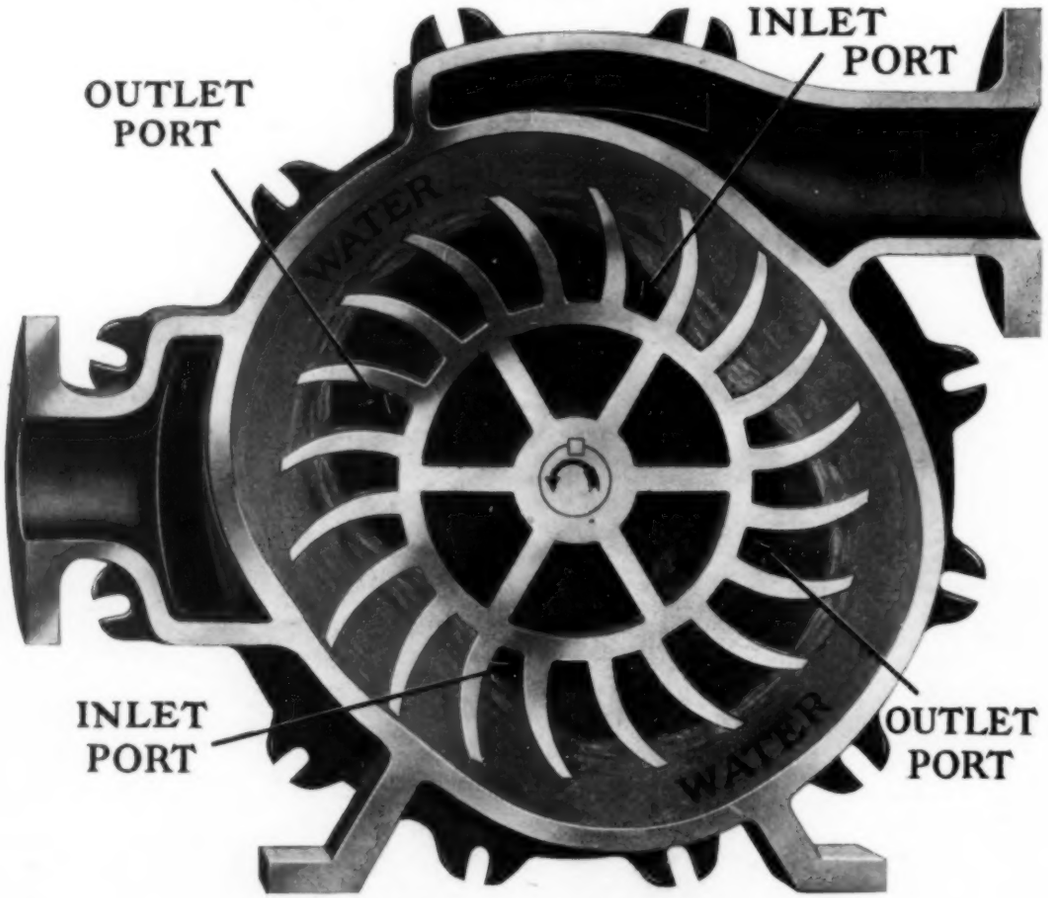
THE DORR COMPANY

ENGINEERS

New York Denver London

NASH HYDROTURBINE

THE SIMPLEST AIR COMPRESSOR AND VACUUM PUMP



Principle of Operation

The water revolves with the rotor but follows the elliptical casing due to centrifugal force. Twice in a revolution the water alternately recedes from and reënters the rotor.

The Water Acting as a Piston Compresses the Air.

The Hydroturbine contains but one moving part, the rotor, which is cast in one piece, with blades reinforced by shrouds cast integral. The rotor is firmly keyed to a substantial shaft which rotates on heavy annular ball bearings mounted outside of casing. The air is thoroughly washed during compression and contains no oil, as the Hydroturbine requires no interior lubrication. Air is delivered by the Hydroturbine without pulsation.

Various liquids may be utilized as the displacing medium, in connection with the handling of chemical gases.

See these pumps in operation at our exhibit, where Nash Engineers will be pleased to explain their application to your problems.

Booths 244 and 245 Mezzanine Floor

NASH ENGINEERING COMPANY

SO. NORWALK, CONN., U. S. A.

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

McGRAW-HILL COMPANY, INC.
Tenth Avenue at 36th Street
NEW YORK

JAMES H. McGRAW, President
ARTHUR J. BALDWIN, Vice President E. J. MEHREN, Vice President
EDWARD CALDWELL, Treasurer JAMES H. McGRAW, JR., Secretary

TELEPHONE, 2840 Greeley. CABLE ADDRESS, Machinist, New York

WASHINGTON, 1410 H. St., N.W. SALT LAKE CITY, Newhouse Bldg.
CHICAGO, Old Colony Bldg. PHILADELPHIA, Real Estate Trust Bldg.
SAN FRANCISCO, Rialto Bldg. CLEVELAND, Leader-News Bldg.
LONDON, Hastings House, Norfolk St., Strand.

H. C. PARMELEE, Managing Editor
ELLWOOD HENDRICK, Consulting Editor
ERNEST E. THUM, Western Editor
WALLACE SAVAGE, Assistant Editor

J. MALCOLM MUIR, Manager

Yearly Subscription price for United States, Mexico and United States dependencies, $3; all other countries, $4. Single Copy, 25c.

When change of address is ordered, the NEW and the OLD addresses must be given. Notice must be received at least 10 days before change takes place. No back copies for more than three months.

Copyright, McGraw-Hill Co., Inc., 1918. Entered as Second-Class Matter at the Post Office at New York, N. Y., under the Act of Congress, July 1, 1918.

Circulation of this issue 12,500 *copies*

CONTENTS *for* September 24, 1918

Volume 19, *Number* 6a

EDITORIAL

The Chemical Exposition and Our Daily Service.....351
Wanted: Public Appreciation of the Chemical Industry..352
Statistics of the Chemical Industry.....352

Opening Exercises at the Fourth National Exposition of Chemical Industries 353

Permanent Chemical Independence. By *Charles H. Herty*

Importance of Chemistry in Industry. By *G. W. Thompson*

America's Supremacy in Electrochemistry. By *F. J. Tone*

The Chemical Industry in Export Trade. By *G. A. O'Reilly*..358

The Slow Growth of Public Appreciation. By *B. C. Hesse*....360

Side-Lights on the Exposition.....361

Program of the Exposition.....361

The Economic Importance of Our Chemical Industry. By *Frederick A. Clawson*.....362

Statistics of Chemical Imports in Preparation.....367

War Disturbances and Peace Adjustments in the Chemical Industries. By *Grinnell Jones*.....368

Abstract of the Census of Chemical Manufactures.....371

The Chemical Exposition and Our Daily Service

At the moment we can think of no industry other than the chemical that could focus attention for a week in war time on a national exposition held in the country's metropolis. It signifies a growing appreciation of the fundamental and basic importance of chemistry in industry and the arts. It is not too much to say that preparations for the event have been under way for a year, for with the closing of each exposition there has been a general reservation of space for the next, and only a short respite before actual plans have been laid for the exhibits themselves.

This year a further tribute to the importance and great public value of the Exposition was paid by the action of the Government itself in permitting the management to proceed with the arrangements in spite of the fact that the great building in which the exposition is held has been commandeered for a military hospital and is undergoing alterations while the show is in progress. Probably no manufacturers in the country are busier than those in the chemical and metallurgical industries. Their time and their products are precious. Labor is scarce and transportation expensive. And yet in spite of all these unnatural drawbacks, busy men have found time to prepare exhibits that are at once interesting to the layman and instructive to the technologist; railroads have transported tons of machinery and material; and the tangible evidence of America's approach to chemical leadership and industrial independence is gathered together in one vast "Exhibit A."

To fail adequately to preserve a record of such an achievement and reflect to the country at large the growing greatness of our chemical industry would be a misfortune indeed. The Exposition would most nearly fulfill its purpose if it could be produced in every important industrial center in the country. This being obviously impossible, it remains for some agency to carry the Exposition to the people, reflecting its activities and reporting its daily proceedings as a tremendous educational force.

Realizing that the full story could never be told in a single issue of this journal, and sensing the need for a timely exponent of the Exposition, we decided to render the service through a series of five daily magazines in which should be expressed some of the prominent phases of our chemical industry. These are identical with the topics for the daily symposia at the Exposition, and comprise: Dyestuffs, explosives and acids; potash; ceramics; metal industries; and industrial organic chemistry. On the subject of explosives we cannot present as much material as we would like, for obvious reasons, but the issue will contain some up-to-date information.

Potash independence is a vital matter to the United States and in the daily devoted to that subject we present what we believe to be the most complete symposium yet compiled. The story of the development of the ceramic industries likewise is typically American and wonderfully encouraging. In metals and alloys we have long held high rank, but the war has stimulated endeavor and produced some new achievements which we record. Finally in organic chemistry in the arts and industries, we recognize a phase of growing importance, and in the issue for Oct. 1 will be found a variety of evidence of this fact. On the whole, the series will constitute a service unparalleled in the records of chemical journalism, but one that is fully justified by the unusual conditions demanding it.

Statistics of the Chemical Industry

Statistics are notoriously unpopular, so much so that speakers always apologize for inflicting them on an audience, and writers refrain from reference to them except in case of urgent necessity. Statistics also are the subject of a certain type of joke, which will readily come to mind, because like isolated passages from the Scriptures, almost anything can be proved by them; also they are grossly referred to as a form a prevarication.

However these things may be, we make no apology for devoting our first Exposition Daily to consideration of the economic, financial and business side of the chemical industry, with a number of pages devoted to its statistical features. There are several reasons why we consider such a presentation timely and sufficiently important to warrant a special issue.

In the first place, intelligent participation in an industry, particularly one that is expanding as rapidly as the chemical industry, requires more than guesswork when it comes to basing future hopes on past performance. Ask almost any small manufacturer what he knows about the production, imports, exports, sources of supply, market for products and general economic conditions in his industry, and we venture to say his reply will show a general, though not necessarily profound, ignorance of the fundamental facts. On the contrary, let a well-managed manufacturing corporation contemplate a new departure in its business, and again we venture the assertion that before reaching a decision it will have studied the despised statistics carefully to see whether the venture is worth while and offers a reward commensurate with the required risk.

Submit the essential economic facts of an industry to analysis and you will have statistics as an important residue after the more volatile and less important elements have been distilled. As basic facts you will have some expression of quantity and value which will measure the importance of the industry for you. Compare and analyze the residue and you will gain information not otherwise obtainable.

The only statistical yard-stick we have for our chemical industry is the census of manufactures for 1914. Although the figures are readily obtainable they are not widely distributed and used. Believing that they should afford a basis for many a sound business survey during these years of expansion, we bring them to the attention of the chemical industry feeling that the effort is warranted once in five years.

Another feature in this issue is an analysis of the chemical industry by the economist and statistician of a great financial and business institution. Banks are following the chemical industry closely, both in its domestic and foreign aspects. A special contributor deals with the latter phase of the industry. No less important is the announcement of the work undertaken by the American Chemical Society to give us adequate information on our imports of raw materials for the chemical industry, as well as finished products. The ultimate achievement of the ambitious plans which the Society has laid out will be worthy of the largest chemical society in the world, in what we firmly believe will become the greatest chemical nation in the world.

Wanted: Public Appreciation of the Chemical Industry

One of the greatest functions of the chemical exposition, particularly in this fifth year of the war, is the education of the general public to a proper appreciation of the importance of chemistry in our national life. If there were no other benefits to be derived; if chemists themselves and their technically trained colleagues gained nothing through inspection of the exhibits and listening to learned discussions; if the industry did not profit in a material way from the efforts expended in the great show; if none of these things resulted, the time and labor involved would still be well spent if the people of the United States would begin to think of our nation in terms of chemistry.

We do not mean to inflict the technical language of the profession on the public, but we do mean that there should be more than a slight comprehension of the fact that chemistry lies at the bottom of industrial independence, and that for the future welfare of our people we must recognize this fact and give it support in matters pertaining to education, legislation, economics and politics. We mean that the public should see to it that the chemist as an individual citizen plays a more important part in our affairs; that he is consulted in matters affecting our national life; that he is even forced out of the retirement of his laboratory and made to function in the body politic.

It has been said in extenuation of the chemist's failure to play a more prominent part, that his work is best done in retirement and seclusion and that he acquires a habit of modesty that prevents him assuming a public rôle. But if the chemist has been backward and modest, his shortcomings are as nothing compared with the failure of public appreciation of his work. Nor is this a new story; it is as old as chemists and chemistry. Elsewhere in this issue we reproduce the words of a wise man of Philadelphia who told his colleagues one hundred and twenty years ago that the United States could never achieve true independence until chemistry played a large part in the country's development. This was spoken but a few years after the revolutionists had thrown off the rule of the mother country and had assumed the rôle of an independent nation. Political independence was a prize worth fighting for, but it required the vision of a chemist to foretell the futility and weakness of an independence not founded on the rock of chemistry. What chemists want today as then, is a public support and appreciation of the fact.

Opening Exercises at the Chemical Exposition

Verbatim Report of Addresses Made by Leaders of the Chemical Industry Touching on Important Public Problems

THE Fourth National Exposition of Chemical Industries was formally opened to the public Monday afternoon, Sept. 23, 1918. The event was signalized by the gathering of a notable body of men who are devoting their time to the application of chemistry in the cause of democracy. The chemical societies were represented by their presidents with the exception of Dr. William H. Nichols, President of the American Chemical Society, who was unable to attend. We present herewith, practically in full, the remarks of the principal speakers.

Permanent Chemical Independence

BY CHARLES H. HERTY

Chairman Advisory Committee

THIS annual assemblage of the products of American chemical industry and of the mechanical appliances by which these products are manufactured provides fitting occasion for a stock-taking of past accomplishments, and a care-taking for the permanency of those additions to our national wealth whereby economic independence may be assured. To secure this independence it is essential that there should be close coöperation between the chemist and the American people, which can only be brought about when the chemist takes the people into his full confidence regarding the problems whose successful solution is a matter of joint responsibility. By the presentation of these exhibits and by open discussion of the problems confronting the industry a sympathetic understanding is produced which creates a sound, intelligent public opinion, which is the greatest asset any industry can possess.

CHARLES H. HERTY

The number of exhibitors continues to grow, in keeping with the continued expansion of the industry throughout the nation. The only disappointment is the setting aside by the Railroad Administration of the large plans which had been inaugurated by the industrial departments of the several railroads for presenting here a marvelous display of those natural resources of this country which still await the touch of the chemist to rise to their true dignity as invaluable assets. It has been deemed necessary to eliminate during war times this most promising and well inaugurated line of development.

In taking stock of the chemical industry first thought turns naturally to the matter of available capital. The amount of capital accessions has continued to grow. During the first eight months of 1918, $59,164,000 was added, making the aggregate authorized capital invested in the industry since August 1, 1914, the date of the outbreak of the war, $386,967,000.

These figures do not include, of course, the investments made by the national Government in the great chemical plants whose output is used solely for war purposes. The total production of these plants sets our Government apart as the largest manufacturer of chemicals in the world. In the after-war period when the story may be told of the rapidity of construction and of the enormous output of these plants it will add a brilliant chapter to the romance of chemistry. Meanwhile we can rest content in the assurance that the great army which we are now hurrying to Europe will be abundantly supplied.

Perhaps the picture of the growth of the industry can best be gathered from a few figures concerning our export trade, for export statistics indicate production in excess of domestic needs, great as these demands have been during the past year. Four items have been selected, three because of their fundamental character, and one on account of the rapidity of its development.

Exports	1913/1914	1917/1918
Sulphuric acid	12,000,000 lb.	68,000,000 lb.
Caustic soda and soda ash	negligible	234,000,000 lb.
Benzol	negligible	25,000,000 lb.
Dyes, dyestuffs and dyewoods	$357,000	$17,000,000

Doubtless in future years these figures will appear diminutive, but at present they constitute an inspiring hope for that future.

A fair measure for that increasing participation of the Government in chemical activity is shown in the supplemental appropriation estimates submitted by the War Department to Congress on September 17, 1918. Aside from the great appropriations for explosives there has been requested for the Chemical Warfare Service, the recently organized division having to do solely with offensive and defensive gas warfare, $198,-

704,000, a sum greater than was asked for the clothing of the increased army we are now raising. Germany began poison gas warfare; within the next twelve months it will have more than its fill of it.

Public Support

The present status of the American chemical industry and its prospect for the future must prove gratifying to all good citizens of this republic, but these prospects can never be fully realized unless the work of the chemist is supported by sound and loyal public opinion, which, in turn, will eventually manifest itself in the form of a thoroughly sympathetic attitude on the part of official representatives of that public opinion.

The stress of war preparations and the great part we feel that we are destined to play in the decision have aroused a wholesome national pride, which should contribute to the development of an atmosphere of good-will. America must make good! America can make good! America shall make good! These thoughts fill the minds of our people to-day. The craze for "imported goods" which has so often palsied industrial effort is now being supplanted by pride in domestic achievement. Certainly the label "Made in Germany" no longer exerts its hypnotic influence over the masses of the world. Yet German propaganda is insidious,, is ever present, and must constantly be combatted if we are to gain that measure of national self-containedness in essential industries which will guard us against a recurrence of the economic tribulations which characterized the period immediately following the blockading of German ports. The chief centers of that disturbance were coal-tar chemicals (dyes and medicinals), and potash; and I beg to ask your serious attention to certain conditions attending the efforts to create these industries in this country.

Dyes and Gas Warfare

No word is needed concerning the marvelous development of the dye industry. It is here to-day for your inspection. Nor need I dwell upon the close relation of this industry to that of high explosives. That point has already sunk deep into our national consciousness. It was appreciation of this relation perhaps even more than economic need, which brought together producers and consumers in a unique display of unanimity which procured from Congress a protective tariff and anti-dumping legislation which guaranteed life for the young industry.

There was an additional argument for such legislation, however, undreamed of by any of us at that time. We had not entered the war, and gave no thought to the efforts which might be required of us in the matter of poison gas production. But when our authorities, following our entrance into the war, determined to meet the Germans with their own weapons and on a scale far greater than they had ever contemplated, it became necessary to make use of every available means for manufacture of toxic material. The great plants planned for government construction and operation were not sufficient for the program. I am violating no confidence in telling you that at this juncture the Government turned to the young dye industry for plants and trained organizations to augment its poison gas output, and splendidly has the young industry responded. For military reasons I am advised not to mention specific plants or the products manufactured therein, but with official sanction I may say that five dyestuff plants are now participating in the production of this material, while many others are contributing indirectly to the same end. The plants were suited to the needs, staffs and workmen were familiar with this kind of work, and the process of conversion to the new rôle was thus enabled quickly to be made.

In view of the adaptability of the dyestuff industry to such serious national needs, it is difficult to be patient with many of our mercantile establishments which still insist upon placarding their counters with signs such as "The color of these goods cannot be guaranteed." What a sweet morsel of comfort these placards are to the enemy, in effect an effort to preserve the market for him, by our own people, if such they are! Was it ever the practice to guarantee all colors? Certainly not, for even before the war nine-tenths of the dyes used were not fast and did not need to be. Moreover, are our merchants not yet aware of the conditions which led for a time to the uncertainties as to color fastness? Do they not know that in the period of acute shortage of German dyes, before the American industry was started, many German dyes were used for purposes never intended, and so gave bad results, in most cases falsely attributed to American origin, and so when remaining German stocks approached depletion, and the American products began to appear on the markets, these were likewise used in ways never intended, with equally as poor results as in the case of the misuse of the German dyes. With the present adequate domestic production, these matters are correctig themselves. Public sentiment can, and I believe will, make an end of the disloyal placards.

Needed Legislation

Assurance of the future of the coal-tar chemical industry lies not only with our people as a whole but even more directly with their representatives in Congress, for it must not be forgotten that legislation stands to-day, as a result of the enactment of the 1916 general revenue bill, which is directly in favor of the German industry, the risk of the very life of the American industry. Every phase of the domestic industry has been studied by the Tariff Commission, and, according to a recent statement of a representative of the Commission, its report to Congress will be published soon after the passage of the revenue bill. While nothing is known of the character of this report, I am confident that when the results of this impartial study of the industry are presented to Congress the same unanimous vote will characterize the correction of errors of existing legislation as has just marked the passage by the House of the eight billion dollar revenue measure. But the time for action is short if we achieve the great military victory in 1919 to which all look forward with supreme confidence. No opportunity must be afforded for the practice of industrial infiltration which may sap the very foundations of the coal-tar chemical industry.

In this connection may I suggest the legislative correction of an error for which we chemists are primarily

responsible. In the existing act intermediates are assessed one-half the duties of finished dyes, which ratio was adopted by Congress upon our recommendation. Experience has shown that this differentiation is a mistake. The difficult stage of production is from the crudes to the intermediates, far more difficult than from the intermediates to the finished dyes. And it is in the field of intermediates that dyestuffs, high explosives and medicinals meet upon common ground. Furthermore, it is evident that when these industries bear the brunt of foreign attack the enemy will take advantage of questions of definition to avoid the higher duties, or will seek to accomplish the same purpose by shipping the lower assessed intermediates for assemblage here into finished dyes by simple processes requiring little outlay. Justification of this contention is furnished by the following extract (page 22) from the "Census of Dyes and Coal-Tar Chemicals 1917" just issued by the Tariff Commission:

> With these exceptions the American dye industry was based entirely on imported intermediates. . . . This peculiar situation was due primarily to the provisions of the tariff laws of 1897, 1909, and 1913, which have consistently placed a higher duty on dyes than on intermediates. In general the German industry dominated the field and the Americans were unable to compete. It happens, however, that in the making of certain dyes the last chemical step of transforming the intermediate into the finished dye is a comparatively simple and cheap process. As the rate of duty on intermediates was lower than that on the finished dyes, the margin in some instances was sufficient to make it profitable to avoid paying the higher duty on dyes, by importing the intermediates and completing the manufacture of the dyes in the United States.

Knowing therefore where the attack will be made, would it not be the part of wisdom for us to strengthen our forces at this point by legislation which will place all of these products on the same dutiable basis?

Coal-Tar Medicinals Equally Important with Dyes

Coal-tar dyes have received an abnormal amount of attention from our people and our press. Of equal importance and of far greater meaning to the comfort and well-being of our people are the coal-tar medicinals. In spite of unfavorable legislation our manufacturers have worthily met their responsibilities in this field. Especially is this noted in the recent statements of government officers that the needs of our Army for these materials had been fully met by our home output. Congress, I am again confident, will correct the unevenness in legislation which hangs as a life-threat over this line of production.

In spite of the lack of coöperation during the past three years some progress has been made. The 1000 tons of K_2O produced in 1915 was increased to 9720 tons in 1916 and 32,000 tons in 1917. Much fundamental investigation has been carried out, and the promise for the future is hopeful. Success can be predicted if producers and consumers get together, and if public opinion is aroused to the fact that failure to secure national independence in this matter vitally affects the entire nation. The mining bill, as modified by Senator Henderson, and now before the Senate, may prove the solution. It may be that protective duties or direct subsidy will be called for, or possibly the relief of capital invested in this industry from war taxation. What ever the cost and whatever the method adopted, Government assistance is needed and may be secured if the demand is nation-wide. Independence in potash can be assured if this country makes up its mind that it will no longer be dependent upon Germany for its supplies, but its mind must be made up quickly. This is one of the most urgent questions, in both its economic and its political aspects, before this country to-day. We cannot afford to neglect it.

Importance of Chemistry in Industry

By G. W. Thompson

President American Institute of Chemical Engineers

THIS National Exposition of Chemical Industries, the fourth that has been held, is a growing illustration of the advantage to our industries which chemistry has afforded. The growth of our industries of all kinds has been greatly assisted by chemists. Strictly speaking, all industries are chemical industries, but some are more obviously chemical industries than others. This exposition has to do naturally more with the industries which are obviously chemical, but the general proposition that all industries are dependent upon chemical processes should be emphasized, even if in each case the connection is not obvious to the unthinking man.

G. W. THOMPSON

We learn by adversity. This war has taught us that all industry is more or less chemical in its character. The fact that the assistance of chemistry has been particularly demanded during the last four years has been due to the fact that our most powerful enemy has been perhaps a little wiser than we have been in the past; and we, seeing the extent to which chemistry could be of service to a nation, both in war and in peace, have learned a lesson, although our education in this respect may not be complete. If chemistry has been of great assistance to us during this war, how much more will it be of assistance to us when the war is over and we are again in competition with a great commercial enemy that earlier learned the lesson of which

I am speaking. The few remarks that I have to make today are in the direction of trying to impress upon our people the necessity of learning this lesson more completely, learning it from day to day, learning it with respect to war and with respect to peace.

Every one needs instruction along this line, but I will address myself particularly, first, to those who control manufacturing operations; second, to the universities and colleges where chemists are taught; and third, to chemists themselves. Those who control manufacturing operations must learn more fully and completely the need of chemical knowledge for the perfection of industry, the need of chemists in their organization. Our universities and colleges must learn that however valuable pure chemistry may be as an interesting study and for the purpose of training the mind, the most important thing that chemistry does is to be found in its application; that while it is extremely interesting and upbuilding to think in terms of atoms and molecules, it is equally important to think in terms of large quantities of the chemical components that enter into reactions. Chemists must learn more fully and completely the need of applying their knowledge to chemical processes conducted on a large scale.

Permit me to elaborate my appeal for a greater education of these three groups of individuals. Again, let me speak to those who are at the head of concerns that control manufacturing operations. They will, without doubt, agree to the broad academic statement that I have already made, that all manufacturing industries are chemical to a greater or less degree and that for their successful prosecution the chemist is an essential factor. Some manufacturers are more progressive than others in this respect, and they are the ones who have made the greatest success in recent years. This academic statement, however, is to be valued by its application. Manufacturers need chemists and they should do everything in their power to secure a supply of the best chemists possible. The progress of manufacturing is dependent upon the development of chemical knowledge, and manufacturers should give their assistance in every way in their power to the development of chemical knowledge.

Manufacturers can do a great deal to help the universities and colleges in developing more efficient methods of instruction. They can do this by calling university and college professors into their councils and developing the practical sides of these professors so that the students in their charge will be developed along lines which will be useful to industry. The teacher in chemistry who is not in touch with practical manufacturing operations cannot properly instruct the student under him and build him up so as to make him capable, on graduation, of entering into the industries and applying his knowledge to their furtherence.

Practical business men often distrust college professors. They say that they are theoretical and visionary. This in many cases is due to the fact that the practical business man has a narrow vision. Sometimes it may be true that instructors in chemistry have not a practical turn of mind. Whether this view of practical business men is true or not, the remedy is in their hands, and if they will see their broad duty, they will throw open their plants more freely to instructors in chemistry and make the education of chemists a part of their organized plan. In other words, our colleges and universities must be used by our manufacturers and our manufacturing plants must be opened to use by our universities and colleges.

Now, let me address another word to our educational institutions. They are not entirely free from criticism. It is my opinion that the educational institutions of this country should give honorary degrees to men who have accomplished big things in the industrial world. The practice in many of these institutions is to give degrees only to those who have done original work in what is called pure science but which work may be of no immediate practical use. It is my opinion that the man who discovers by hard labor things of practical value in the chemical world is deserving of some recognition from our colleges for his contribution to practical science.

I believe that our universities and colleges should, all of them, turn more to the practical aspects of education. Many of them think only of its cultural side. Culture is desirable; no one questions this, but culture is not incompatible with an education that suits a man for the practical affairs of life. It is absurd to say that a man, to be successful in the business world, must be a boor, for its corollary is that the man of culture cannot succeed in the business world. Culture with an education that will make the student of practical use is what we want, and the educational institution that thinks only of culture is about as bad off as the educational institution that thinks only of the practical affairs of life. Our educational institutions should keep in touch with manufacturing operations, and instructors in chemistry should keep their feet upon the earth, even if we cannot expect them at all times to keep their heads out of the clouds.

Since this war started it has been a wonderful thing to see how chemists generally have offered themselves to our Government in the hope that they would be able to help in solving the practical problems confronting it. Many instructors of academic chemistry descended from their exalted positions and attempted to handle problems which they, by experience, have been unfitted to solve. All honor to these men; we do not criticize them, and have only praise to offer for their self-sacrifice. How much better would it have been, however, if these men had been better acquainted with the practical matters with which they became intrusted. They came nobly to our country's assistance. They broke down the barriers with which they were surrounded, and it is a delicious hope that when peace arrives they will not allow these barriers again to be erected.

To chemists generally I address this word: You have the power of influencing the opinion of manufacturers, those that control industries and the opinions of those who control the policy of our educational institutions. I would ask you to insist upon it that the manufacturers of our country and our educational institutions get closer together and that between them there be opened up wide avenues of intercourse. The result will be that each will be modified. Our industries will be influenced by our educational institutions and our educational institutions will have breathed into them some of the life of the business world.

We all know that this exposition is to be a success, but success in the best sense of the term involves the

power of growth. Success does not consist only in the doing of single definite things, but in the bigger sense means the doing of a series of definite things, each member of the series being of a greater value than that which immediately preceded it. My few remarks are directed to the desire that chemists and chemical industries, and expositions of this kind will have the vitality and growing power so that each succeeding achievement will surpass that which preceded it, in a progressive and developing series.

America's Supremacy in Electrochemistry

By F. J. Tone
President, American Electrochemical Society

During the past four years we all must agree that the chemical industry of America has passed through the most important period of its history. This has been a war not only between efficiently organized armies and nations but between efficiently organized industries. Our chemical industry today is pitted against the chemical industry of Germany and one has only to study this great exposition to be convinced that the American chemist is going to measure up to his opportunity. At the beginning of the war our industry was highly organized in special fields but it lacked symmetrical development. It was unbalanced. It lacked self-containedness and coördination. It has taken the war to enable the chemical industry to find itself and it has likewise taken the war to enable this country to discover that it has a great chemical industry and to recognize it as a great national asset; and it must be said that one of the big forces which have worked toward the progress of chemistry and toward public recognition of chemistry in America has been this exposition. We give all honor to the men whose foresight and energy made this possible.

F. J. TONE

In this big forward movement of the past four years the electrochemist has played a large part. America has long enjoyed a supremacy in electrochemistry, but in spite of the strong position of the industry before the war no one would have dared to predict the expansion which the war would demand of us. It has called for chlorine, cyanamide, air nitrates and phosphorus in vast quantities. It has required the ferro-alloy industry, the electrode industry, and the abrasive industry to quadruple their outputs.

As a single example, consider briefly the contribution of electrochemistry and electrometallurgy to the aircraft program. The airplane motor has a crank case and pistons of aluminium. Its crank shaft and engine parts subject to the greatest strains are all composed of chrome alloy steel. All of these parts are brought to mechanical perfection and made interchangeable by being finished to a fraction of a thousandth of an inch by means of the modern grinding wheel made from electric furnace abrasives. Calcium carbide and its derivative, acetylene, are making possible an ample supply of cellulose acetate for airplane dope. When the aviator trains his machine gun on an enemy plane his firing is made effective by tracer bullets of magnesium or phosphorus. When our bombing planes begin to carry the war into Germany, it will be with bombs perhaps of ammonium nitrate or picric acid or other high explosives all depending largely in their manufacture on electrochemical reagents. Without the pioneer work of Hall, Acheson, Willson, Bradley and others, the present aircraft program would be absolutely impossible of achievement.

Then there is gas warfare, the very basis of which is chlorine. Germany has long been a nation of chemists and when she planned a war of frightfulness it followed as a matter of course that she should seek to make it also a war of chemical frightfulness. Much as we deplore it, therefore, we have been forced to throw our best energies to the solution of the problems of gas warfare. It is interesting to note that chlorine, the product of the electrolytic cell is the basis of mustard gas, chlor-picrin, phosgene and almost all of the important war gases. Thus does electrochemistry enter fundamentally into the modern military machine.

It is important for us to remember that while we are working to develop our industry to a point where it will meet the demands of the war, our work is only begun. If this is, in a measure, a chemists' war we must work to see that afterwards we have a chemists' peace. After the war will come bigger problems and bigger responsibilities; no one will have a bigger opportunity than the chemist to make life better and to serve his fellow man. We have the problems of the conservation and proper utilization of our resources, the elimination of wastes, the problems of foodstuffs, clothing and sanitation. All these problems and many others touch the everyday life of the people and are pre-eminently the problems of the chemist. Fortunately the nation is coming to realize to what an extent it depends in war and in peace on the work of the chemist. By the establishment of the Chemical Warfare Service, our place in the military organization has been definitely recognized. We want the same recognition in the councils of the nation after the war. We want the Government to recognize the value of scientific methods and we will look to this exposition in future years as one of the forces which will visualize to the rest of the country the role of the American chemist.

The Chemical Industry in Export Trade

The American Manufacturer Must Study Foreign Conditions and Be Prepared to Meet the Most Exacting Requirements of Foreign Buyers. The Chemist Must Commercialize His Abilities in a Higher Degree

By G. A. O'REILLY
Foreign Trade Representative Irving National Bank, New York

THE after-the-war foreign-trade problem to be solved by the chemical industry of this country is about the same as the big general problem which must be solved by all the other industries which hope to operate successfully in the foreign field.

The details involved in the process to be considered are well known to the experienced, and must be provided for in domestic trading as well as in that which concerns foreign fields. A market must be found, sufficient information concerning the essential conditions affecting that market must be secured, the product must be manufactured with proper reference to the requirements of the particular market, and there must be secured such a cost of production, treatment and distribution as will make it possible to meet the competition of similar products that may be coming from other sources of supply.

Some of our American industries have solved this foreign-trade problem and have mastered the essential details concerned with considerable thoroughness. Steel, oil, copper, tobacco, cotton, several machinery, equipment and appliance lines, and certain of our special lines have reached the point in foreign trade success where they are able to meet the keenest foreign competition to be met.

It will be found, too, that a large number of American general lines also have been introduced and distributed in the foreign field in a manner which contributes most effectively to our foreign trade standing, but in many such cases success accomplished has resulted not from the activity of manufacturers, nor from any intelligent appreciation on their part of the problems to be solved in foreign markets, but from the efforts of the highly developed class of institutions known as export commission houses.

From the earlier days of our experience with world markets, houses of this class have figured most importantly in the development of American foreign trade. They have studied the foreign field, have come to understand its requirements, have created organizations capable of treating the difficulties of credit, transportation and distribution and, in general, through the intelligent development of facilities, have effectively bridged the commercial chasm which under other conditions would separate the greater portion of our American product from foreign markets in which it might be absorbed to the benefit of all parties concerned.

In recent years there has been developed among even smaller American lines a disposition on the part of manufacturers to break away from export commission houses, and deal direct with the foreign customer. In many such cases, where the entire situation has been thoroughly understood results have been satisfactory but in others, where the particular manufacturer assumed that there was in his situation some quality of merit which would justify him in disregarding the experience of the export commission house concerning facilities actually required, difficulty has been encountered.

If the manufacturer wishes to deal direct with his foreign customer, he will find it entirely practicable to do so, but in so doing he must realize that in each transaction there is required a more or less standard unit of facilities. In other words, if he depends upon some short cut to success, he is apt to be severely disappointed.

Of course there are among our products those whose natural popularity in world markets is so great that these markets will make almost any effort, however unreasonable, in order to get them. This condition of affairs is particularly noticeable at the present time when the demands of war must be satisfied regardless of price or convenience or anything else. It will be found, though, that even in the most conspicuous of these cases, steel, oil, etc., the necessities of the foreign purchaser have not been allowed to interfere with the dvelopment of American facilities of distribution. Indeed, in point of completeness of facilities all along the line, these major industries are among the most highly developed in existence.

No Easy Road or Short-Cut to Success

This rather extensive reference to the general aspect of American foreign trade bears upon the future of the chemical industry in world markets as showing that there is no easy or cheap way of achieving success. From the beginning, clear through to the end of each foreign trade transaction there are certain requirements which must be met, certain classes of service which must be provided. Whether they are to be provided by the manufacturer, by the jobber, by the export commission house, or otherwise, is unimportant in this discussion—the important thing is that they be provided.

The markets of the world must be surveyed and studied so that the particular product concerned will operate abroad under most favorable instead of the least favorable conditions. The wishes, tendencies, and even the peculiarities of the particular market selected must be considered as of fundamental importance. If a particular population wants a product in a certain condition or in a certain size or color, or even in a certain class of container, it is up to the American manufacturer and exporter to recognize these requirements, otherwise it will be found much better to select some other market. It will not be enough to provide a good product, even a better product than the foreign market has in mind. This is particularly true of

Oriental peoples. Like the man in the song, "They want what they want, when they want it."

Our Chemistry Must be Commercialized

Nor is there anything in the chemical situation which will justify any disregard of these requirements upon their part. As far as the difficulties to be encountered are concerned, theirs is just a plain, ordinary foreign-trade problem, with perhaps an occasional new element of difficulty which is not encountered in other lines. It will not be enough to assume that the foreigner does not know what he wants—not enough to assume that he will be content with a leftover portion of some product which has been manufactured without any intelligent reference to his needs or wishes or whims, and above all it will be fatal to success to assume that he is under any obligation to reconcile his points of view or standards or business policies with ours. If we wish to play with him we must recognize the rules of the game as he understands them. If not, we must make up our mind to play with someone else. It is a very practical case of the old idea of "fish or cut bait."

Quite naturally, and because of certain conditions for which nobody in particular is to blame, but which are in the situation nevertheless, the chemical industry in its relations with the foreign market has more to do, more to overcome than the average American industry similarly interested. In a very considerable sense, and excepting a rapidly growing number of chemical concerns, this industry has not yet been commercialized. Certain of its products are well established in the domestic market, and in the foreign markets as well—certain of the great commercial concerns of the country have specialized in the commercial treatment of chemical products as highly as has been done in any industry, but in general, a large part of the industry still seems to be on a professional rather than a commercial basis.

Chemists Should Control the Chemical Industry from A to Z

When we realize the almost mysteriously professional nature of the processes which result in the creation or preparation of the chemical product, it is not difficult to see why the commercial end of the industry, as far at least as the old school type of chemist is concerned, should be given a position of secondary importance only. But on the other hand, when we realize the ease with which in these times, and under modern methods of operation, the experimenter or discoverer becomes in turn a manufacturer, a financier, a distributer, it is not easy to understand why such a large percentage of the really high-class members of the chemical industry should be satisfied to be called in by some concern for the solution of certain of its problems, or with executing one or two of the perhaps numerous processes involved in completed commercial treatment, or with any other participation which stops short of proper control of the industry and a proper share in its profits.

This is only a layman's view of the case, and there may be perfectly good reasons why the situation is as it is, but the prodigies of accomplishment which were so clearly shown in the chemical exposition of last year in this city, leave no doubt in the mind of the layman as to the class of ability represented in that industry. It is difficult to believe that these men who have done these impossible things should find it necessary to shy at the much simpler tasks of financing industries, or distributing their products. The chemical industry of this country in relation to foreign trade still is in its early infancy. It required a world war to puncture the bubble expressed in the theory of a necessary dependence upon Germany. What a wail went up when our American business discovered that the war had cut off our former German source of supply for dyes, and how skeptical nearly everybody was concerning the possibility of that supply being replaced from domestic sources within reasonable time—and how beautifully it all has worked out, and how easy it all seems now, and how independent we feel of Germany and all the other countries of the world, not only as regards dyes, but in at least a dozen other lines, for which before the war we had depended almost absolutely upon the intelligent enterprise of foreign lands.

Sharp Competition Will Return After the War

And now, after a while, the war will be over—the markets of the world will be opened, commercial monopolies such as we now know so intimately no longer will exist, or at least will be seriously disturbed; competition again will come back into the field, real competition, sharper perhaps than we have known in the past. Our world-known and commercially established chemical products probably will continue popular in the markets of the world, but this will not be enough. The lessons of the war regarding the possibilities of our own people must not be lost. Our chemical industry should claim in the markets of the world the same privilege which in the past this country so freely accorded to the chemical products of other countries.

In this process, best results in the chemical industry will be possible only when the chemist realizes that after all he and not the financier who invests, or the distributer who exports is the important element in the case. Professional he must remain, but not to the exclusion of the other impulses and qualities which the commercial world recognizes as indispensable to commercial success.

German Industry and the War

The *Société de Chimie Industrielle* has recently issued a special number dealing with German industry and the probable effects of the war upon it. The industrial condition of Germany before 1914 is described, and the excellent means now being adopted to better her position are pointed out, high tribute being paid to her spirit of investigation and organization. Finally, Germany's post-war aims are reviewed, and the lessons that France and all the Allies have to learn are put forward very strikingly and clearly. It is shown that Germany is concentrating all her attention upon measures for regaining her position in the world markets, and the need for reform in the training of science students in France is emphasized. Laboratory work and chemistry generally need more encouragement, and, as in England, science and industry must be brought into closer co-operation. It is an encouraging sign that the *Société de Chimie Industrielle* is rapidly increasing in membership and resources, and its efforts deserve and will no doubt attain to success in the highest degree.—*Chemical News.*

The Slow Growth of Public Appreciation

An Account of the First Campaign For the Chemical Independence of the United States — The First "Nitrate" Committee

BY BERNARD C. HESSE, PH. D.

THE American public has at last discovered its chemists! The importance of the chemist and of chemistry in science and every-day life seems now to be fully realized, at any rate suitably acknowledged, by the American public. That this did not take place until 1914 is in no way due to failure of the chemist to tell the public how important he and his science are, but to his inability to make the public give heed to him, as the following extracts from "Chemistry in America," by Edgar F. Smith, Provost of University of Penn., show.

On April 11, 1798, just over 120 years ago, Thomas P. Smith in closing his Annual Oration before the Chemical Society of Philadelphia, the first chemical society in the world of which any record remains, said:

"I shall now, gentlemen, conclude with a few observations on the utility of a general diffusion of chemical knowledge throughout America.

"Living as we do in a new, extensive, and unexplored country, separated by an immense ocean from all other civilized nations, we must feel ourselves deeply interested in a knowledge of *its* mineral productions, and this can only be arrived at through the medium of chemistry. As far as our very limited knowledge has yet gone, we have every reason to believe that nature has been far from bestowing her blessing upon it with a parsimonious hand. Abounding as it does with the richest ores of the most valuable metals, we should be committing a crime of the blackest dye, were we through *willful ignorance* to trample under foot these invaluable gifts of the Creator.

"The only true basis on which the INDEPENDENCE of our country can rest are AGRICULTURE and MANUFACTURES. To the promotion of these nothing tends in a higher degree than chemistry. It is this science which teaches man how to correct the bad qualities of the land he cultivates by a proper application of the various species of manure, and it is by means of a knowledge of this science that he is enabled to pursue the metals through the various forms they put on in the earth, separate them from substances which render them useless, and at length manufacture them into the various forms for use and ornament in which we see them. If such are the effects of chemisry, how much should the wish for its promotion be excited in the breast of every American! It is to a general diffusion of a knowledge of this science, next to the VIRTUE of our countrymen, that we are to look for the firm establishment of our INDEPENDENCE. And may your endeavors, GENTLEMEN, in this cause, entitle you to the gratitude of your FELLOW-CITIZENS."

During all the years since the American chemist has conscientiously lived up to the admonitions of Thomas P. Smith, he has done his appointed share. *The public alone did not respond.*

Five Philadelphia chemists on February 3, 1798 advertised "to the citizens of the United States" that in the interest of public benefit they would analyze free of all charge any minerals sent them. They did this pursuant to a resolution formed by the Chemical Society of Philadelphia certainly made arrangements for public work in the most patriotic spirit, and the record shows that they accomplished much. In 1799 the same Society apointed a committee of three (two of them among the preceding five) to get together all information as to domestic sources and modes of manufacture of niter, an indispensable ingredient of gunpowder. Here was the fore-runner of the "Nitrate Committee" recently appointed by President Wilson to determine how best to make "nitre" from the air. In 1802 the same Society offered a medal, at a cost of $50, to the person who could produce the best specimen of clay for potters' ware in the United States.

Nor were the chemists of those days recluses; most of them were active in other professions and sciences, in politics, religion and in public affairs of many kinds. Nor were they "woman-haters" as the following, published by Smith in 1789 and earlier, show:

"I shall now present you with the last and most pleasing revolution that has occurred in chemistry. Hitherto we have beheld this science entirely in the hands of *men!* we are now about to behold *women* assert their just, though too long neglected claims, of being participators in the pleasures arising from a knowledge of chemistry. Already have Madame Dacier and Mrs. Macaulay established their right to criticism and history. Mrs. Fulhame has now laid such bold claims to cheistry that we can no longer deny the sex the privilege of participating in this science also." And again:

"Chemistry is a science particularly suited to women, suited to their talents and their situation; chemistry is not a science of parade, it affords occupation and infinite variety; it demands no bodily strength, it can be pursued in retirement; it applies immediately to useful and domestic purposes; and whilst the ingenuity of the most inventive mind may be exercised, there is no danger of inflaming the imagination; the judgment is improved, the mind is intent upon realities, the knowledge that is acquired is exact, and the pleasure of the pursuit is a sufficient reward for the labour." (Letters for Literary Ladies, before 1798).

The American chemists of more than one hundred years ago said it all! How similar to what we have repeatedly heard as being "news" since 1914? The outlines of the picture as a whole were all supplied by them; filling in the detail was all that was left to do; the American chemist of today has done that and has always done it well. *May the American public never again lose sight of its chemists!*

Side-Lights on the Exposition

THE show, as a thing in itself, looks familiar. The Buffalo Foundry is in its old place on the main floor at the western end, the National Aniline is in its old place at the east end, south of the main entrance while the du Ponts have taken greater space than heretofore to the north of the entrance. The Norton Company is where it was and so are J. P. Devine and Co., Arthur D. Little, Inc., the General Bakelite Co.—and then comes the Barrett Co. moved over next to them. These and many other names are growing familiar even to those who visit the show to learn chemistry. The exhibits themselves on the other hand, display the greatest diversity from previous Septembers. Not only in things but in the manner of exhibiting them there has been a material change since 1914. The main purpose of the undertaking was to enable manufacturers to improve their methods and technique with materials and apparatus of which they had not been theretofore informed, and to discover how their activities might be extended; but it has gone much further than this. Exhibitors are using all kinds of devices to explain not only what they make but, as far as it is reasonable to tell, how they do it. In a first, hurried glance around the Grand Central Palace and without looking at a single exhibit thoroughly, we obtained the general impression, somehow, that the public was a great school and the exhibitors were competitive teachers. Earnest efforts are made to explain the relations of materials to each other.

* * *

On the second floor, or rather the main balcony, the Chemical Warfare Service of the U. S. Army has an exhibit in charge of Major F. E. Breithut, formerly a professor at the College of the City of New York. In thirty feet of space along the corridor it displays more particularly the developments in chemical warfare, in which everyone admits the Germans were the pioneers. In many respects we have learned to view with doubt the German claims for chemical originality; to reconsider the manifold boasts to which we formerly listened with attentive and credulous ear, and to subject them to a generous discount. But poison gas and torture gas as munitions of war are products of German Kultur and if we only believed that the Kaiser is right and that he speaks the truth, we should be constrained to acknowledge that their introduction has been accomplished under Divine guidance.

Our gas warfare is carried out under the auspices of two divisions; defensive and offensive. Originals and photographs of the various allied types of masks as well as those of the enemy are shown. The new American type is also displayed and its future use in mines is clearly indicated. Offensive gas warfare is also represented by specimens of shells and grenades of many sorts.

They are designed for the various different types —sneeze, mustard lethal, phosphorous (for incendiary work and to produce white smoke) and others. An oval form of shell is shown among others that may fall into any position without becoming a dub, which is a shell that fails to explode. We may have more to say about these things later in the week.

Program of Fourth National Exposition Chemical Industries

Grand Central Palace, New York
Week of Sept. 23, 1918

The addresses comprise a series of symposiums devoted to a consideration of

THE DEVELOPMENT OF CHEMICAL INDUSTRIES IN THE UNITED STATES, NOTABLY SINCE JULY, 1914.

Tuesday, September 24th

Afternoon (2:30 P.M.) Symposium: ACIDS and CHEMICAL ENGINEERING.

E. J. PRANKE (American Cyanamid Co.), Development of Nitric Acid Manufacture.

EMERSON P. POSTE (Elyria Enameled Products Co.), Developments in the Manufacture of Glass Enameled Apparatus.

Evening (8 P.M.) Motion Pictures.

THE OIL INDUSTRIES

*The Story of a Cake of Soap.

*Light from the Rocks; Natural Gas (4 reels).

Lake Asphalt Industry (Barber Asphalt Co.).

Asphalt Roofing Industry (Barber Asphalt Co.).

Asphalt Colloids (Barber Asphalt Co.).

(9 P.M.) Speakers:

J. A. SWITZER (University of Tenn.), Waterpower Potentialities of East Tennessee.

HERBERT C. HENEGAR (American Zinc Co.), Mineral Resources of East Tennessee. (Representing Knoxville Chamber of Commerce.)

Wednesday, September 25th

Afternoon (2:30 P.M.) Symposium: POTASH.

C. A. HIGGINS (Hercules Powder Co.), Recovery of Potash from Kelp.

LINN BRADLEY (Research Corporation), Recovery of Potash from Iron Blast Furnaces and Cement Kilns by Electrical Precipitation.

JOHN W. HORNSEY, Potash from Desert Lakes and Alunite.

ALFRED DE ROPP, JR. (American Trona Co.), Potash from Searles Lake.

Evening (8 P.M.) Motion Pictures.

Electrical Precipitation of Potash from Cement Dust (Research Corporation).

*Colloid Chemistry.

The Operation of a By-Products Coke Plant (2 reels). (H. Koppers Co.)

Moving a Forest to France (4 reels). (Southern Pine Association.)

The Story of Potash—Production at Searles Lake.

The Economic Importance of Our Chemical Industry

The Chemical Industry Has Shown Wonderful Ability to Expand to Meet Unusual Demands Created by the War—Has Grown Much Faster Than Our General Manufacturers — United States Acquiring a Position of Independence

BY FREDERICK A. CLAWSON
Economist and Statistician, The National City Company

IN 1914, the United States imported $137,180,000 of chemicals, explosives etc., while the exports were only $65,696,000, leaving a net excess of imports over exports of $71,484,000. In 1916, exports were $914,072,000, or an increase of $848,376,000, while imports had increased only $50,860,000, making a net increase in domestic production, due to increased exports, of $797,516,000, or 67 per cent of the entire manufactures of 1914. In the same period petroleum production increased 9.8 per cent and coke production 57 per cent.

EXPANSIVE POWER OF THE CHEMICAL INDUSTRY UNDER SUDDEN DEMAND

The chemical industry of the United States has shown greater efficiency and greater powers of quick response to business demands than almost any other of the great industries of the country. War requirements have made special demands upon our chemical industry, and that it has responded with great promptness and in a way evincing great possibilities of expansion is illustrated by the fact that exports of chemicals in 1917 were practically seven times as great in value as in 1914, the year immediately preceding the war, while exports as a whole were only three times as great as in 1914. Government figures of all chemicals, drugs and dyes exported from the United States were, in the fiscal year 1914, $27,079,000; in the fiscal year 1917, $187,846,000 and in the fiscal year 1918, $180,000,000. Even this does not tell the full story because the great group called "explosives," in which the growth has been far more striking, is so closely allied to the chemical industry as to be in fact a part of it, and in explosives the growth is from $6,272,000 in 1914 to $820,000,000 in 1917, and to $400,000,000 in 1918. While perhaps we would not class cartridges, gunpowder or dynamite as strictly "chemicals" the fact that the group which includes all of the unenumerated articles now included under the general head of "other explosives" grew from less than $1,000,000 in 1914 to $420,000,000 in 1917, and to $37,000,000 in 1918, shows that in the industries closely allied with chemicals the growth has been quite as striking as in chemicals proper. In the articles which may be considered as strictly "chemicals" the growth in exports illustrates the great expansive power of this branch of our industries. Acids, for example, exported in the fiscal year 1914 amounted to less than one-half million dollars in value, in 1915 $3,000,000, in 1916 $24,000,000, in 1917 $55,000,000, and in 1918 approximately $48,500,000. Dyestuffs, of which we expected to be in very great need by reason of the cutting off of the usual source of supply from Germany, actually showed very large gains in exports, the total value of exports of dyes and dyestuffs having grown from one-third of a million dollars in 1914 to over $1,000,000 in 1915, more than $5,000,000 in 1916, $12,000,000 in 1917 and $16,500,000 in 1918, and this exportation, it should be understood, of $16,500,000 worth of dyes and dyestuffs in the fiscal year 1918, occurs exclusively in domestic products, and does not include any foreign dyes re-exported.

Soda salts and preparations, of which the exportation was so small in 1914 that the Government did not find it necessary to make a record, jumped to more than $3,000,000 in the fiscal year 1915, $12,600,000 in 1916, $18,000,000 in 1917, and to $22,950,000 in 1918. That mysterious group "all other chemicals" in which are included many new articles chiefly for war work, grew from $9,000,000 value in 1914 to $22,500,000 in 1915, $56,000,000 in 1916, $75,000,000 in 1917 and $42,000,000 in 1918. These figures are cited especially to illustrate the expansive power of this, one of the most important of the manufacturing industries of the United States.

COMPARISON WITH OTHER GREAT INDUSTRIES

The importance of the chemical industry is evidenced by comparison of the amount of capital and value of products turned out with that of other leading industries. The value of capital of the group known as "chemicals and allied industries" as shown by the census of 1915 was in 1914 $723,000,000, and that of the group distinctly classed as "chemicals" $224,000,000. Let us compare these two totals—$723,000,000 for "chemicals and allied industries" and $224,000,000 for the distinct group known as "chemicals"—with those of some of the other great industries. In the great woolen, worsted and felt goods manufacturing industry the total capital in 1914 was but $413,000,000, or but a little more than one-half that of all chemical and allied industries. In the silk-goods industry, which turns out $250,000,000 worth of goods per annum, the capital invested was but $210,000,000 as against $224,000,000 in the group strictly known as "chemicals." The total capital of the great automobile industry in 1914 was but $408,000,000, or little more than one-half that of "chemicals and allied industries," while that of the great flouring mill industry, which turns our grains into condition for food was but $380,000,000 or but about one-half that of "chemicals and allied industries." Even the great cotton manufacturing industry, which turns more than one-third of our enormous cotton crop into form for use shows a capital of but $900,000,000, or a little more than that of "chemicals and allied industries."

The growth of the chemical industry is illustrated by the fact that the total capitalization of "chemicals and allied industries" as shown by the 1915 census was more than 9 times as great as in 1880, and more than 3 times

as great as in 1900, the figures of capital for "chemicals and the allied industries" having been in 1880, $86,000,000; in 1900, $239,000,000; and in 1915, $723,000,000, while the value of the product turned out was in 1880, $99,000,000; in 1900, $203,000,000, and in 1915 $548,000,000.

Growth of Invested Capital, Labor and Value of Products

This comparison of the growth of capital with that of value of products turned out calls attention to some extremely interesting facts with reference to the requirements of capital in this great industry, and the disposition to substitute capital for labor in production, as is the general custom in all of our industries. A comparison of the census figures of capital, number of employees and value of products turned out in the distinctly "chemical" industry (not including the group known as allied products) shows that the capital employed has increased much more rapidly than the number of men employed. The census of 1880 shows the number of employees in the distinctly chemical industry at 11,000 and in 1915, 37,782; while the capital stated in 1880 was $29,000,000 and in 1915 $224,000,000; thus the number of employees in 1915 was but about three and one-half times as many as in 1880, while the stated capital invested in the industry was in 1915 nearly eight times as much as in 1880; the increase in number of employees was 243 per cent and in capital 672 per cent. The value of products turned out in the strictly "chemical" industry grew from $38,600,000 in 1880 to $158,-$53,000 in 1915. In the group "chemicals and allied products," the capital grew from $86,000,000 in 1880 to $723,000,000 in 1915, and the product turned out from $99,000,000 in 1880 to $548,000,000 in 1915.

Attention is especially called to the fact that in the gradual substitution of capital for labor, in this as well, as in other industries, the amount of capital utilized in turning out a dollar's worth of material is materially greater than formerly, although the amount of labor used in turning out a dollar's worth of material is distinctly less than formerly. In the group "general chemicals" the amount of product turned out for each dollar of capital invested was in 1880 $1.33, and in 1915 but 70c. for each dollar invested in the industry. In the great group "chemicals and allied products" the amount of products turned out for each dollar invested, as shown by the census of 1880, was $1.15, and in 1915 74c. for each dollar invested, while as already indicated the increase in labor employed was at a far less rate than that of capital.

It is in the power of our chemical industry to rapidly enlarge its products and to quickly respond to the demands made upon it as this great industry develops, but unfortunately we are unable to closely measure the growth resulting from the demands of the war, since the latest census (that of 1915) relates to the operations of the calendar year 1914, of which only a small part was sufficiently within the area of war activities to have been materially affected in the matter of its output. The only means of measuring the growth since the census, is by the value of chemicals exported, which grew from $27,000,000 in 1914 to $46,000,000 in 1915, $124,000,000 in 1916, $187,846,000 in 1917 and approximately $180,000,000 in 1918, this estimate for 1918, being based upon official returns for 11 months and an estimate for the closing month of the year. Meantime the importation of chemicals show only a moderate growth, though this slow growth in chemical imports since the war began is probably due in some degree to the fact that the markets of Germany, from which we brought large quantities of this class of merchandise, are no longer open to us. Chemicals imported have increased from $88,000,000 in 1914 to $120,000,000 in 1917, a gain of about 50 per cent in imports, while exports of chemicals increased over 500 per cent during the war period to 1917. Chemicals imported reached $150,000,000 in 1918, a gain of about 70 per cent in imports, while exports of chemicals increase over 540 per cent.

United States the World's Greatest Exporter of Chemicals

A very large proportion of the chemical industry is found in the section east of the Mississippi. In New York State the group "general chemicals" in the year 1910 (the latest year for which we have figures in detail) were $35,000,000, New Jersey $22,000,000, Pennsylvania $16,000,000, Michigan $13,000,000, Ohio $8,000,000, Massachusetts $6,000,000 and Illinois $5,-000,000, all of these figures being in very round terms. It is not practicable to compare with any degree of accuracy the chemical industry of the United States with that of other countries by reason of the fact that the classification or groupings by the different countries of materials of this character differ so radically that the group termed "chemicals" in the official returns of one nation is liable to differ radically in the articles included from that of other countries. Prior to the war the United States was looked upon as one of the world's greatest importers of chemicals and held a comparatively low rank in the exportation of chemicals, especially when compared with certain European countries, notably Germany, France and Great Britain. Since the war the exports of chemicals of the European countries have of course greatly declined and their imports increased, and as a consequence the United States doubtless stands at the present moment as the world's greatest exporter of chemicals when measured by total value. This leadership of the United States in the world's export trade of chemicals must be considered as probably only temporary, though the enormous growth in our exports of chemicals does suggest great possibilities awaiting that industry in supplying the demands of the importing world.

Tables I, II and III show the imports into the exports from the United States of chemicals from 1910 to 1918, also the production of the group classed as "general chemicals," and of the greater group known as "chemicals and allied industries" as shown by the United States census figures for each census year from 1880 to 1915.

TABLE I—IMPORTS AND EXPORTS OF CHEMICALS INTO AND FROM THE UNITED STATES 1910 TO 1918

Fiscal Year	Imports	Exports
1910	$76,803,000	$21,416,000
1911	79,731,000	23,007,000
1912	77,123,000	25,117,000
1913	94,241,000	26,575,000
1914	88,039,000	27,079,000
1915	79,250,000	46,381,000
1916	109,123,000	124,478,000
1917	124,770,000	187,846,000
1918*	150,300,000	180,000,000

* June estimated.

TABLE II—PRODUCTION OF GENERAL CHEMICALS IN THE UNITED STATES AND CAPITAL EMPLOYED

(U. S. Census Figures)

Census of	Capital	Product	Value of Product per Dollar of Capital	Employes	Wages and Salaries
1880	$29,000,000	$38,600,000	$1.33	11,000	$6,200,000
1890	55,000,000	59,400,000	1.08	17,100	10,100,000
1900	89,100,000	62,700,000	.71	21,200	12,100,000
1905	96,600,000	75,200,000	.77	22,600	14,800,000
1910	155,100,000	117,700,000	.75	27,600	20,300,000
1915	224,355,000	158,053,000	.70	37,782	31,087,003

TABLE III—PRODUCTION OF GENERAL CHEMICALS AND ALLIED PRODUCTS AND CAPITAL EMPLOYED, 1880 TO 1915

(Allied products include fertilizers, explosives, dyestuffs, essential oils, wood distillates, sulphuric and nitric acids, carbon, bone and lampblack, and paints and varnishes)*

	Capital	Product	Value of Product per Dollar of Capital
1880	$86,000,000	$99,000,000	$1.15
1890	180,000,000	125,000,000	.69
1900	238,500,000	202,500,000	.84
1905	324,100,000	281,000,000	.90
1910	483,700,000	425,100,000	.83
1915	722,989,000	547,802,000	.74

*Figures not absolutely comparable because of changes in classes of articles included especially in 1890 and 1900.

Our exports of chemicals to our neighbors at the South are rapidly increasing. Exports of chemicals to South America in the fiscal year 1914 (the year immediately preceeding the war) showed a total of $3,106,000; in 1915, $4,484,000; in 1916 $10,886,000; and in 1917 $15,000,000. For the fiscal year 1918 the complete figures are not yet at hand, but it is probable that they will show a total materially greater than that of 1917, and if the increase in chemicals is as rapid as that of other merchandise to South America the total for chemicals in 1918 would approximate $20,000,000.

Revival of Natural Dyestuff Industry

A once powerful industry, revived to something of its old proportions by the far-felt effects of the war, is the production of natural dyestuffs. Barred from accustomed supplies by the war's blockade, American color consumers clutched in desperation at any straw promising relief, and the long-dormant natural dye trade was revivified. Today the United States is the largest manufacturer of natural dyes in the world, and even after peace has shrunk the present abnormal consumption, the demand for natural dyes should show a permanent increase of from 15 to 25 per cent. The future, then, of the dyestuff industry in this country seems to be full of hope and promise. If we accept our opportunity, and develop our resources with intelligence and wisdom both in legislation and in manufacturing methods, there is no reason why America and not Germany, should not be the dyestuff center of the world.

Since the war cut down England's exports of heavy chemicals there has been a perceptible shift toward New York as the center of gravity of the trade. However, the growth of production and trade in the United States has been rather to supply domestic needs than to build up an international trade. It hardly seems likely that the United States will in any way supersede England as the principal exporter of these products.

Sulphuric Acid, the Basic Heavy Chemical

What may be called the basic heavy chemical, that from which many of the others are manufactured, is sulphuric acid, whose uses, besides the present important one of explosive manufacture, include its employment in the refining of oils and petroleum, the reclaiming of rubber, the preparation of artificial fertilizers, the manufacture of aniline dyes, and metallurgy. It is also used in making other acids, in the Leblanc process for making soda from salt, and in bleaching.

Under normal conditions a very large proportion of the acid used in industry is manufactured on the spot. The difficulty and danger of handling it in bulk, and the relatively steady demand tend to keep it out of the open market and to minimize its importance in international trade. Germany was the chief country exporting it, shipping annually some 80,000 tons to adjacent European countries. Belgium also exported her surplus. The domestic production of each of the principal consuming countries, however, was far in excess of imports. Table IV gives the approximate production in 1913 of the countries using this acid.

TABLE IV—PRODUCTION OF SULPHURIC ACID

	Long Tons
United States	3,500,000
Germany	1,650,000
Great Britain	1,150,000
Italy	640,000
France	550,000
Belgium	350,000
Russia	260,000
Sweden	130,000
Japan	75,000
Spain	16,000

The demands of the explosives makers and of the iron and steel industry since the war began have caused a greatly increased production in the belligerent countries, which has meant the investment of large sums in new plants. The United States in 1916 produced 5,642,000 tons, and nearly 7,000,000 tons in 1917. After the war demand ceases it is likely that the efforts of the producers to find a market will cause the acid to become a larger factor in international trade than before.

Trade in Pyrites and Sulphur

The production of sulphuric acid in any country is of course entirely dependent on the supply of the materials from which it is made, principally pyrites and sulphur. It is these which are transported to the point of consumption rather than the acid. The movement of pyrites in 1913 may be seen in Table V.

TABLE V—MOVEMENT OF PYRITES IN 1913

	Production, Tons	Net Imports, Tons	Net Exports, Tons	Consumption, Tons
Spain and Portugal	1,283,904	.....	1,200,000	84,000
Norway	441,291	.....	460,912	(Very small)
United States	341,338	848,674	.....	1,190,012
France	306,267	186,348	.....	492,615
Italy	287,777	.....	.....	.....
Germany (1912)	258,517	1,070,794	.....	1,329,311
Canada	141,577	.....	49,000	92,000
Russia (1912)	123,990	.....	.....	.....
Japan	114,387	.....	.....	.....
Hungary	104,050	.....	.....	.....
Great Britain	11,427	794,740	.....	806,167

The Spanish supply was the controlling factor in the world's market, and led the price movements. It is in the hands of a number of native mine-owners and is of the most desirable quality. The largest part of it went to Germany and Holland, with the United States next as buyer. Great Britain and France also took large quantities. The Norwegian pyrites went chiefly to Germany. The war, although greatly stimulating the demand for pyrites, at the same time has cut off from the rest of the world one of the largest purchasers—Germany. The scarcity of ships and the high freights on such a bulky material have tended to encourage consuming countries to develop their own supplies rather than to depend on imports. Germany has undoubtedly been hard put to it to replace the loss of the Spanish

supply. Great Britain, being practically without domestic supplies, has imported Spanish pyrites in increased quantity. Her total imports in 1916 were 951,206 tons. The United States similarly took larger quantities of the Spanish ore, 854,432 tons in 1914, 747,027 in 1915, and 1,117,968 in 1916. Early in 1917 however, owing largely to the German submarine warfare, the shipments to this country of Spanish pyrites stopped, and have only recently been resumed. The domestic production in the United States had been steadily growing through the opening of new mines.

The world's trade in sulphur, which normally is used chiefly in the manufacture of paper pulp, has been shifted. It forms a larger item of trade than the manufactured pulp, and is mined in comparatively few places. Table VI gives the total movement of sulphur in 1913.

TABLE VI—MOVEMENT OF SULPHUR IN 1913

	Production, Tons	Net Imports, Tons	Net Exports, Tons	Consumption, Tons
Italy and Sicily	413,727	.....	414,717	(Small)
United States	311,640	.....	67,101	244,539
Japan	65,467	.....	11,650	53,817
Spain	62,653	.....	.....	.....
New Zealand	12,000	.....	.....	.....
Austria	10,561	38,142	.....	48,703
Chile	4,400	.....	.....	4,400
Canada	.....	32,984	.....	32,984
Germany	1,251	43,265	.....	44,516
Great Britain	.....	18,519	.....	18,518
Sweden	.....	39,715	.....	39,715

Germany Dominated World Market for Bleaching Materials

Another group of heavy chemicals upon which the war has had a considerable effect is that of the various bleaching materials, which are all-important to the textile trade. The world's production of bleaching powder is estimated at 500,000 tons a year. It was obtained chiefly from England and Germany. England, besides producing very large quantities for her own industries, exported in 1913 some 36,319 tons of the material, of which 27,362 came to the United States. England also supplied the distant markets such as India, China, South America, and numerous other countries. In most of the world market, however, especially in Europe, the German product had attained a dominating position. The growth of the electrolytic manufacture of caustic potash from the abundant potash deposits of Stassfurt, in which chlorine is a by-product, had made possible the production of bleaches at a very low cost, in a quantity far in excess of home requirements. The exports in 1912 were 32,254 tons, of which the United States as principal buyer took 9574 tons. France also manufactured a small exportable surplus, in addition to supplying her own extensive textile industries. Bleaching powder was not made commercially outside of Europe until the opening of the electrolytic works at Niagara Falls in 1900. Since then the American output has increased rapidly, although not keeping pace with consumption. The United States consumption in 1913 was about 57,600 tons, of which the domestic production supplied only 19,600 tons.

The war of course completely removed German bleaches from the market, and also cut down British exports considerably, owing to domestic scarcity. In their place American and Japanese bleaching powders have appeared. The electrolysis of common salt in the United States has been largely instrumental in increasing the supply. Demands poured in from foreign buyers, and the United States has become an important exporter of this product.

United States Will Be Self-Supporting in Bleaching Materials

The return of peace will find the United States, formerly the principal buyer of bleaches, quite self-supporting. It is a question, however, whether the American product will be able to compete abroad with the cheap British and German product.

The consumption of bleaching powder during the past few years has been affected by the extended use of liquid chlorine which was formerly produced only in Europe, chiefly in Germany, but which is now manufactured here in large quantities and finds an extensive use in reclaiming scrap metal as well as in bleaching. Sodium peroxide, also much in demand as a bleach, is now made at Niagara Falls, replacing the European imports. Caustic soda, which is produced at the same time with chlorine in certain processes and is used in any number of industries—soap making, the manufacture of paper pulp, the mercerizing of cotton, the purification of mineral oils etc—was obtained from England before the war chiefly. Germany specialized more in caustic potash and did not compete directly. The war has cut down British exports from 75,000 tons to a very small figure, and as in other lines the United States and Japan have partly taken the place. The impossibility of obtaining soda in the usual markets has caused a foreign demand here that has taken up all that the producers could spare.

A similar situation exists in the case of the carbonates and soda ash. England is normally the chief factor in the world markets, exporting some 200,000 tons a year. British exports have kept up well since the war began, but nevertheless the United States has found it profitable to export these products where they were imported before the war.

In the cyanides, essential to metallurgy, and the chromates and sulphates (saltcake), Germany formerly controlled the market, England being second. The United States was a large buyer of cyanide, but recently the Niagara Falls works have produced large quantities.

Dislocation in Fertilizer Movements

In the field of fertilizers, in which the largest international movements of chemicals took place before the war, the dislocation has been large. Potash, over 90 per cent of which is used for fertilizers, has been most affected, as Germany is practically the sole source. The Stassfurt mines, operated by German capital, are united in a close kartel or monopoly of which the German government is a member, which fixes the output, handles all sales throughout the world, divides it into portions for domestic use and export, and fixes wholesale prices. Owing to the complete monopoly, prices have always been entirely artificial and yielded large profits.

The United States was by far the largest consumer outside of Germany herself. The efforts to produce potash here from Western alkali lakes, alunite, and Pacific kelp, although aided by government appropriation and stimulated by the high prices since the cessation of imports from Germany, have had small results compared to the normal consumption. Foreign sources, such as those near Barcelona, Spain, have not been more successful. The German mines, on the other hand, although cut off from most of their outside markets,

have been kept running by war demands at home, producing 904,000 tons in 1914; in 1915, 680,000 tons; and in 1916, 714,000 tons. In view of the fact that prices could be considerably lowered from their pre-war level without jeopardizing profits, there seems so far little likelihood that the German monopoly will be less secure when peace is signed. The substitutes that have been developed, however, will undoubtedly affect consumption in industries other than the fertilizer. Potash salts are used to a great extent in making soap, fireworks and glass. The substitution of soda compounds for potash in making glass, which has been very successfully carried out, will come near making the world independent of German glass. A similar substitution is proving a success in soap making. Potash explosives are not made now to any great extent outside of Germany.

Nitrates, Natural and Artificial

The recent action by the Government of the United States for the establishment of works for the production by artificial process of the nitrates for which the United States has been heretofore dependent upon the supplies imporated from the great nitrate beds of Chile, calls attention to the wonderful development, especially since the beginning of the war, in the art of obtaining nitrate from the air.

In the five years preceding the war Germany imported an annual average of 700,000 tons of nitrate of soda from Chile, France about 350,000, Belgium for herself and neighbors about 350,000, Great Britain 150,000, the remainder of Europe about 300,000 tons, and the United States about 500,000. While some of this was used for the production of explosives, especially by Germany and France, and also limited quantities for the production of nitric acid for chemical industries, a very large proportion was used in times of peace as soil food.

Practically all of the nitrate supplies of the world have in the past come from Chile, whose exportations have in recent years averaged about 2,400,000 tons per annum, and the importations of Europe and the United States have as above noted aggregated about 2,300,000 tons per annum in the five years preceding the war. With the opening of the war all of the great importers of nitrates, Germany, France, the United Kingdom and the United States, realized the importance of greatly increasing their nitrate supplies for use in manufacturing war material as well as a continuation of its use for soil food.

The quantity of nitric acid required by the United States Government for its own uses in the manufacture of explosives is estimated at 20,000 tons per annum in times of peace, and in time of war 180,000 tons, while that of the other countries may be measured by the fact that Germany has increased the product of the nitric acid-producing materials to an equivalent of 100,000 short tons in 1915 and 320,000 in 1917.

Summary of Progress Since 1914

In summarizing the progress in the chemical industries since 1914 it is interesting to note that we are exporting dyes and chemicals to Germany's old clients. For instance in 1917 we sent Spain $3,192,000 worth of dyes, as against a total which was not important enough to enumerate in Government statistics in 1914. France took $1,404,576 worth against $49,000 in 1915 and less than that in 1914. Mexico took $576,000 worth in 1917 against $2,000 worth in 1915, Argentina $423,000 against $32,000, and Brazil $1,395,000 compared with $11,000. British India imported from us $1,237,000 worth compared with $11,000 in 1915.

Before the war 90 per cent of the artificial dyes and colors were imported, five or six concerns with 400 operatives producing 3300 short tons per year. Now there are over 100 enterprises, each making special colors and over 100 concerns making crudes and intermediates. Sulphuric acid has doubled in production. In 1916, 6,250,000 tons of 50 degree Baumé were produced. The estimate for 1917 is much greater and the production for 1918 will again greatly increase. Gasoline production has increased from 35,000,000 to 70,000,000 barrels per annum since 1914. The production of explosives and consequent consumption of nitric acid has increased enormously. The smelting of all metals, iron, zinc, copper, antimony, tin, mercury etc., and the production of their alloys, has increased to meet the country's needs. Potash importation from Germany was stopped by the war and its production in this country in 1917 was over 28,000 short tons. By-product coking doubled its capacity in the last three years. Light oil, which contains the benzene and toluene needed for explosives, jumped from 7,500,000 gallons in 1914 to 60,000,000 gallons in 1917 and is again being largely increased. Ammonia production has increased 100 per cent in three years and the visible supply is insufficient to meet the demands. From these facts it is easy to realize that the growth of the chemical industries in the United States since 1914 has been phenomenal. Not only have factories sprung up to manufacture products formerly imported, but great expansion has taken place to supply the increased demand for all chemical products. The country now manufactures practically everything required along chemical lines. These are but a few instances of our chemical progress, but they show that we can go forward with every confidence of no serious shortage of the many chemical products required for domestic consumption or foreign export.

Five-Hundred-Ton Government Powder Plant at Nashville

This plant is being built in nine units—each one complete in itself. One of these units is approximately eight times the size of the largest smokeless powder plant in the United States prior to 1914. The entire plant is 70 times as large as the largest plant before the war. It covers an area one and one-half miles wide by three miles long. To operate it at capacity will require 1,500,000 pounds of nitrate of soda per day—675,000 pounds of sulphur per day. It will consume 4500 tons of coal for each 24 hours, which is equivalent to 100 carloads, or two trainloads. It will require 100,000,000 gallons of water per 24 hours, or as much water as is used by a city having a population of one million people. The central power plant will contain 68 boilers, each with a rating of 825 horsepower. It will be the largest smokeless powder plant in the world and the last word in powder making. It will require 20 to 25 thousand men ten to twelve months to complete it.

Statistics of Chemical Imports in Preparation

The American Chemical Society Adopts Comprehensive Plan to Give the Chemical Industry Vital Information Regarding This Country's Chemical Dependence

THE Council of the American Chemical Society took no more important action at the recent Cleveland meeting than its adoption of the report of the committee coöperating with the Bureau of Foreign & Domestic Commerce in obtaining statistics on chemical imports for the fiscal year 1913-1914. The recommendations of the committee call for the appointment of a permanent Committee on Import Statistics, comprising the editor of the *Journal of Industrial & Engineering Chemistry* and the vice-president of the American Chemical Society. The plan of action will result in giving us for the first time an intelligent comprehension of our chemical dependence as well as a basis for building wisely in the future.

A great deal has been said in general terms during the past few years about our chemical dependence on foreign countries, particularly Germany. To a certain extent this has been true, although it is possible that the real facts have been exaggerated. In any event there was but one way to ascertain the real extent of our dependence, and that was to analyze the invoices of imported chemicals, raw or finished, in the Bureau of Foreign & Domestic Commerce, and list the items therein contained. In this way alone would it be possible to arrive at information which was essential to any intelligent efforts to build up the chemical industry in this country.

Largely through the efforts of Dr. B. C. Hesse, who has been the leading spirit in this matter for the American Chemical Society, and the coöperation of Dr. E. R. Pickrell of the U. S. Appraisers' Stores of the Port of New York, the laborious task of reviewing the invoices of the Bureau of Foreign & Domestic Commerce has been under way for some time past and promises to be completed by December 1, 1918. An idea of the extent of the work involved can be gained from the fact that upward of 20,000 invoices of imported chemicals has to be segregated from a total of more than 500,000 general invoices from all ports of entry. From these 20,000 invoices it was then necessary to transcribe the individual items, which will amount to more than 4000.

The information which will be gained regarding these 4000 items will comprise:

1. The name of the chemical, or material for the chemical industry.
2. The total quantity imported, expressed in pounds or other units.
3. The total value, expressed in dollars.
4. The countries of origin, arranged in the order of their participation, and showing the percentage of such participation.

It is expected that this information will fill a book of about 300 pages, which will be issued about February 1, 1919, and sold to the public at 30 cents per copy. Here, then, we will have the true story of our chemical dependence in 1913-1914, the last normal year before the war. We will know what we imported, and how much; what it was worth and where it came from. With these facts at hand we should be able to determine the possibility of independence and whether it is worth striving for. In some items the game may not be worth the candle, or we may not have the requisite raw materials in this country. In such an event our manufacturers will be well advised to dismiss any thought of engaging in their production.

Coöperation of Governmental Agencies

But in the conception of Dr. Hesse's committee it will not do to stop with this information, for still more important and valuable data are to be obtained by elucidating these statistics. He recommends that the American Chemical Society classify the 4000 or more items of import into groups showing their mineral, animal or vegetable origin. Having done this he would seek the coöperation of governmental agencies in ascertaining foreign and domestic resources of these materials. It requires no stretch of the imagination to discern the far-reaching influence of such a plan. The Geological Survey, for example could prepare a concise statement of the world's resources of the items of mineral origin. This would show whether or not we have a domestic source of supply of a given material that would support local manufacture in case someone undertook it. It would show our resources and deficiencies, and suggest to the Survey the most profitable lines of search for minerals. Similarly the Department of Agriculture would coöperate on the items of animal and vegetable origin. There would remain then, to complete our economic knowledge of these 4000 items of import, only a statement of the industrial and commercial uses of the materials. And we understand that the Tariff Commission has been approached on this score, with the prespect of securing the desired coöperation.

A Pepmanent Committee Charged With Responsibility

When the foregoing is an accomplished fact we will know the extent of our dependence on foreign countries. When that is known it will be time to compile similar statistics and data on our chemical exports and our domestic production. The achievement of these ends will leave little to be desired for the intelligent direction of our chemical industry. But in order to accomplish the purpose it is necessary that some permanent body be charged with responsibility for the results and vested with the requisite authority to produce them. Hence the committee's recommendation that two officials of the American Chemical Society be charged with this duty. The committee is properly small—two, with power to add to their number and invite coöperation from other societies. The service to the industry is worthy of the American Chemical Society, and we look to see an early and satisfactory performance of duty.

War Disturbances and Peace Readjustments in the Chemical Industries*

A Bird's-Eye View of the Dislocations of Normal Trade and Industry Caused by the War—Expansion for War Needs—New Uses Must be Discovered for Chemicals Now Devoted to War Purposes

BY GRINNELL JONES
Chemist to the United States Tariff Commission

WHEN peace is restored the competitive strength of the nations in all industries will have been profoundly altered. Chemistry and machinery have played a larger part in this war than in any previous war, and therefore the greatest changes may be expected in the metal working and in the chemical industries. Moreover, our new American cargo ships will make us more than ever interested in foreign trade. The Tariff Commission is actively studying these war disturbances in order to assist in the readjustment and reconstruction that must follow when peace comes.

Among the chemical industries, the first to feel the stimulus of war was the explosive industry. The expansion of American smokeless powder plants was sufficient to prevent a German victory in France and Russia in 1915. It is not revealing military secrets to say that there has been some growth since 1915. We all hope that the peace terms will be so satisfactory that the military explosive plants themselves will no longer be needed. Nevertheless, there will be a permanent increase in the competitive strength of the American chemical industries through the growth of the subsidiary industries which now supply the raw materials to the explosive industry.

SULPHURIC ACID PRODUCTION DOUBLED

Our production of sulphuric acid is at least twice what it was before the war. The growth has been largely in contact acid, and therefore when the demand for explosives disappears, the American chemical industries will have available large supplies of pure and concentrated sulphuric acid. Moreover, the growth of the acid industry has been made possible by a great increase in the production of American sulphur and by a smaller although significant increase in the mining of pyrites.

The nitric acid industry has grown relatively more than the sulphuric acid industry. The output of nitric acid from Chilean niter is now more than ten times as great as it was before the war.

The significance of this growth of the sulphuric and the nitric acid industries to our dynamite, dyestuff, and pyroxylin plastic industries need not be emphasized here.

SYNTHETIC AMMONIA AND NITRIC ACID

Of greater significance than this stimulus to industries already well established has been the birth of new industries. We have a new synthetic ammonia and nitric acid industry. Plants have been built and, during the war at least, will be operated by the Government. When the full story of these plants can be told, it will reveal that American chemists have, under the pressure of war needs, been able to devise substantial improvements upon the Haber and Ostwald processes developed by the Germans before the war. These processes were the result of nearly two decades of work on these problems as a part of their military preparedness. It is not improbable that after the war nitric acid made from synthetic ammonia may prove to be cheaper than nitric acid made from Chilean niter. In any case American agriculture will assuredly have a new large source of nitrogeneous fertilizer materials.

LARGE SUPPLIES OF BENZOL AND TOLUOL AFTER THE WAR

In 1914 our production of crude light oil would have been sufficient for the production of only about 4,500,000 gallons of benzol and of about 1,500,000 gallons of toluol, and only a part of which was distilled. As is shown in our forthcoming report on the production of American dyes and coal tar chemicals, in 1917 our output of benzol was 40,200,000 gallons, and of toluol was 10,200,000 gallons. In 1918 further substantial growth is to be expected through the installation of stripping plants at city gas works. The toluol is now going almost entirely into explosives as is also a considerable fraction of the benzol. When the demand for explosives disappears, it is to be expected that the prices of benzol and toluol will drop to the point where it will be profitable to add them to gasolene for motor fuel. A similar condition will probably exist abroad and, since America has the greatest known natural resources for the production of gasolene, benzol and toluol should be as cheap or cheaper here than abroad. Therefore the industries consuming benzol and toluol may be assured of ample supplies of these materials at favorable prices.

SYNTHETIC PHENOL AND MONOCHLORBENZOL ARE WAR BABIES

Before the war we had no synthetic phenol industry, whereas in 1917, as is shown in our forthcoming report, 15 plants produced 64,146,499 pounds of phenol valued at $23,715,805, most of which was used in making picric acid. If this new industry is to survive, there must be a greater consumption of phenol in the industries for peaceful purposes. Fortunately, phenol is used as an intermediate in the manufacture of some representatives of every class of finished coal-tar chemical products including dyes and lakes, photographic developers, medicinals, flavors, perfume materials, synthetic resins, synthetic tanning materials and explosives. Leaders in the chemical industries are already making plans for

*An address delivered at the meeting of the American Chemical Society in Cleveland, September 10.

the industrial development of the uses of phenol when the phenol is no longer needed for explosives.

Another war baby is monochlorbenzol, which was made during 1917 by eight American firms, with an output of nearly twenty-five million pounds, valued at a little less than five million dollars. The dye industry will use a part of this productive capacity permanently, but new discoveries by American chemists will probably be needed to utilize the total productive capacity. Incidentally, this product furnishes a new outlet for chlorine, a new by-product source of muriatic acid and raises a new problem in the utilization of dichlor-benzol, an unavoidable byproduct.

Before the war there was but one producer of aniline oil in the United States. In 1917 there were twenty-three producers with an output of 28,806,524 pounds, valued at $6,758,535. As only a relatively small proportion of this substance goes into explosives, the peace readjustments will not be complicated by a collapse of a military demand, but will depend primarily on the competitive strength of the American industry.

The war has also stimulated the production of mercury for the manufacture of fulminates. The American production has about doubled since the beginning of the war. Formerly we had a balance of imports; now we have a larger balance of exports.

Influence of Gas Warfare on Chemical Industry

Poison-gas warfare is also destined to have a permanent influence in the chemical industries. Although there is no reason to expect that uses will be found for phosgene and mustard gas on a scale approaching the present and prospective military use, the plants erected for their manufacture need not prove a total loss when the military demand ceases. Nearly all of the noxious substances used in poison-gas warfare require chlorine for their manufacture, and an increase in the production of chlorine in the United States is therefore certain. There is much hope that some of the substances produced as intermediate steps in the manufacture of the poison gases may be utilized for purposes other than warfare, but these are matters not yet to be discussed. Phosgene, except for the dangers attending its use, is an excellent reagent for many processes involving chlorination or dehydration and for making Nichler's ketone. Fortunately, the risk in using phosgene is greatly minimized by the development of the new gas mask. The intensive work which hundreds of American chemists have been and are doing to improve the design of the gas mask will undoubtedly prove a blessing to workmen exposed to noxious fumes in chemical factories throughout the world when peace is restored.

Acetone, Acetic Acid and Butyl Alcohol

Still another industry which has been stimulated by a direct war demand, is the manufacture of acetone, which is used as a gelatinizing agent in the manufacture of the explosive, cordite; as a solvent for airplane dopes; and in the manufacture of poison gases. Before the war, acetone was obtained entirely as one of the products of the wood distillation industry, but there are now at least four new processes in commercial operation in the United States or Canada for the manufacture of acetone.

It has been found that glucose can be fermented by a suitable organism to give acetone directly. Butyl alcohol is a byproduct of this fermentation, and becomes commercially available in appreciable amounts. The development of uses for butyl alcohol is an attractive problem.

The other processes for making acetone produce acetic acid or an acetate as an intermediate step, and may therefore permanently affect the acetic acid industry. The most obvious and perhaps the simplest of these processes depends on fermenting molasses to alcohol, which is then converted into acetic acid by the rapid vinegar process. The conversion of acetic acid into acetone in an old and well known process, but the details have been improved.

Another process depends on making acetylene from calcium carbide. By the aid of a suitable catalyst, the acetylene is made to combine with water yielding acetaldehyde which may be readily oxidized to acetic acid. Still another process depends on fermenting [illegible] under such conditions that sodium acetate and potassium salts are secured.

The war has stimulated the production of many other products, a few of which may be briefly mentioned: castor oil for lubricating airplane motors; phosphorus for incendiary bombs; barium and strontium nitrates for signal rockets. The output of soda ash has increased by 68 per cent since 1914, and the output of caustic soda has more than doubled.

Curtailment of Imports Affects Dye Industry

New conditions in the chemical industries have also been created by the curtailment of imports. As a direct consequence of this stoppage of imports from Germany a new American dye industry has been established. It is true that some dyes were being made in the United States before the war, but the makers relied on Germany for the necessary intermediates, with the exception of a small amount of aniline made here by a single producer. During 1917, 134 different intermediates were made by 118 firms. One firm made 53 different intermediates. Dyes were made by 81 firms. The total production of dyes in the United States during 1917 was approximately equal in gross weight to the annual importations before the war. The exports of American dyes exceeded in value, although not in quantity or variety, our imports before the war. The dye industry is not dependent on any imported raw material except sodium nitrate from Chile. Many important dyes are still lacking, but indigo and alizarin are now on the market in significant amounts, and the vat dyes for cotton derived from anthracene are coming.

A new potash industry has also arisen, but its future does not seem so promising as the future of the new dye industry. Here Germany has an inherent geological and geographical advantage. Although shipments from Germany ceased early in 1915 and although prices have advanced to about ten times the pre-war prices, the American production during 1917 was only about 13 per cent of our pre-war consumption. This relatively small production was obtained from many sources and by many processes. There is an excellent prospect that the recovery of potash as a byproduct of cement mills will survive German competition and ultimately supply about one-third of our needs. In addition, significant amounts will probably be secured as a byproduct of the pig-iron

blast furnace. That the other branches of the potash industry can survive German competition is open to serious question.

Utiliuing Shipping Capacity to Best Advantage

Within a few months after the outbreak of the war, imports to the United States from Germany and her allies came to an end. As the months went by, it became increasingly difficult to obtain cargo space for imports from any part of the world. Now the limiting factor in the American participation in the war is shipping for our troops and their supplies, and therefore ships are no longer free to seek the most profitable cargo and route, but are being assigned to routes and cargoes by the Shipping Board on the basis of military needs rather than profits. The Shipping Board has organized a Division of Planning and Statistics, which is making a study of world commerce and the military and civil requirements, for the purpose of utilizing available shipping in a way that will contribute most to the winning of the war. Military requirements make it essential that an abnormally large proportion of the world's shipping shall be used in the North Atlantic. This has made it necessary to curtail imports from other parts of the world to essential requirements.

W. B. D. Penniman of Baltimore is the chemist on the Staff of the Shipping Board. He must decide what chemicals need not be imported at all, and the amounts of others which must be imported to supply essential needs. The importance of this work can perhaps best be made clear by an example. The Shipping Board, after consultation with the Food Administration, decided that ships could not be spared for the importation of tapioca from Java and the Straits Settlements. The War Trade Board accordingly announced that licenses for the importation of tapioca would not be granted. Efforts were immediately made to secure a modification of this order on behalf of manufacturers of nitro-starch for the Army, and on behalf of manufacturers of mucilage for the Post Office Department. Nitro-starch which, in the United States at least, was hardly beyond the experimental stage at the outbreak of the war, has been improved until it is now one of the safest of all explosives to handle and finds important military uses. Until a few months ago it was made from tapioca. Penniman, however, succeeded in convincing the officers of the War Department and the manufacturers that a satisfactory product could be made from corn-starch.

The details of the manufacture have been worked out coöperatively by the starch producers, the manufacturers of nitro-starch and the experts of the War Department with such success that nitro-starch from corn is not only better but more economically produced than nitro-starch from tapioca. The Post Office Department also readily agreed to use some locally available material instead of tapioca for mucilage on stamps. The shipping saved on this one item of tapioca for nitro-starch is sufficient to transport and sustain in France more than twenty-five thousand fighting men. Mr. Penniman's services to the nation on questions of this character deserves to be better known and appreciated. Imported materials for the time being should be used with the utmost economy and only for essential needs. American chemists can render valuable public service by finding substitutes for materials which must be imported from overseas.

It seems probable that many of the discoveries in regard to the use of substitutes for imported materials made under this pressure of war needs will prove of permanent value and have a permanent influence on international trade.

Dislocations in the Fertilizer Industry

A third source of war disturbances in the chemical industry has been due to the diversion of materials from their customary use to war uses. The fertilizer industry has probably made the greatest sacrifices of this sort. Sodium nitrate and ammonia are required for the manufacture of explosives in such large quantities that the amount left for use in fertilizers has been and will be much reduced. Raw phosphate rock has of course been plentiful but the acid used in the manufacture of acid phosphate has been largely diverted to making explosives. The relatively small supplies of potash have been very high in price and normal amounts have not been available at any price. The peace readjustments may however be expected to bring compensation to the fertilizer industry. Large new supplies of nitrogenous fertilizer materials will be available from the new nitrogen fixation plants. The new and enlarged sulphuric acid plants must again find the chief outlet for their product in the making of fertilizers. Finally, the German monopoly of the potash market is likely to be broken through the French control of Alsace and the new developments in America and Spain when peace comes. It is therefore reasonable to expect a large increase in the manufacture and use of fertilizers with a resulting benefit to all producers and consumers of food.

Chlorine also is likely to be diverted from its normal uses to the manufacture of poisonous gases to a considerable extent. In spite of the erection of new plants it is quite probable that we may all be asked to use paper lacking in the whiteness to which we have been accustomed.

Chemists in industries using chlorine should prepare to facilitate this diversion now, and plan to use more chlorine later when the military demand ceases.

It is evident that the *status quo ante* cannot be reestablished in the chemical industries any more than it can be reëstablished in international relations. Peace will bring new conditions of international competition and radical readjustments in industry from a war basis to a peace basis.

The Tariff Commission is endeavoring to secure and have ready for immediate use all information likely to be helpful to Congress in determining the part which the tariff is to play in these readjustments. We desire information in regard to the industrial development and technical progress of industries throughout the world; in regard to the sources of their raw materials and the uses of their products, and in regard to any changes in conditions likely to have a permanent influence on costs of production, or the competitive strength of industries here and abroad. The assistance and coöperation of manufacturers, importers and consumers in the collection and interpretation of the information mentioned is desired.

Washington, D. C.

Abstract of the Census of Chemical Manufactures

A Comparative Statistical Analysis of the United States Census Taken in 1909 and 1914—Production and Financial Data on Fifty Chemical Industries

EVERY five years the United States takes a census of its manufactures. The last census of its chemical industry, taken in 1914, will have special interest and significance in the future because it represents the status of the industry during the initial year of the Great War. Through a mere coincidence it also happens that these statistics on the chemical industry represent its condition in what will prove to be its last "normal" year prior to our entrance into the war, for beginning with 1915 Europe made increased demands on our chemical manufacturers and greatly stimulated the business in this country. As the war progressed it became increasingly evident that American chemical industry was destined to grow apace, not only to restore to normal conditions some lines of business that had been upset by the disturbance of foreign commerce, but also to meet the abnormal demands of warring nations. It is obvious, therefore, that the census of 1919, when taken, will afford some interesting comparisons, because by that time our chemical industry will have become well established and the statistics will have assumed an importance they have never had before. In the meantime it seems appropriate to familiarize ourselves with the figures and data for 1914 as a yardstick for the future. When the data for 1919 are available we will devote space to a comprehensive abstract and comparison with 1914. In the following statistics we have retained the table numbers used in the Abstract of the Census of Manufactures, 1914, to facilitate reference to that volume for those who may wish more data than are given here. General statistics for the various chemical industries prior to 1914 may be found in Table 223 of that volume.

The principal items reported in the census are given in Table 1 which shows that the manufacturing industry of the United States as a whole experienced the most rapid growth during the five-year period 1904-1909. in Table A[1] Dr. Bernhard C. Hesse has compared in a most instructive way some of the data given in Table 1 for all industries with corresponding data for the chemical industry. It appears that in the period 1909-1914 the chemical industry grew at a much faster rate than did our general manufacturing industry.

[1] *Journ. Ind. & Eng. Chem.*, Dec., 1917.

Rank of the Chemical Industry

The census report distinguishes 344 industries, although for certain purposes some of these are subdivided into several branches, so that in the aggregate there are reports on 615 classes or sub-classes of industry. In 1914 there were 56 of these industries which had each a gross value of products of $100,000,000 or more. The relative importance of chemicals among the 56 industries is shown in Table 5, the rank for gross value of products being 42; for average number of wage-earners, 46; for value of material, 40; and for value added by manufacture, 36.

As a matter of fact, the value of materials used and the value added by manufacture are better measures of the relative importance of manufacturing industries than gross value of products. On this score the chemical industry made a good showing, because the value added by manufacture raised the rank of the industry nearer first place as compared with value of materials, and both these items were higher in rank than gross value of products. In the case of average number of wage-earners the rank is lowered, indicating that labor is relatively a smaller part of the gross value of products than in some other industries.

TABLE I

	Manufacturing Industries		Per Cent of Increase[1]	
	1914	1909	1909–1914	1904–1909
Number of establishments	275,791	268,491	2.7	24.2
Persons engaged	8,263,153	7,678,578	7.6	23.6
Proprietors and firm members	262,599	273,265	—3.9	21.1
Salaried employees	964,217	790,267	22.0	52.1
Wage earners (average number)	7,036,337	6,615,046	6.4	21.0
Primary horsepower	22,547,574	18,675,376	20.7	38.5
Capital	$22,790,979,937	$18,428,269,706	23.7	45.4
Salaries and wages	5,366,249,384	4,365,612,851	22.9	37.1
Salaries	1,287,916,951	938,574,967	37.2	63.4
Wages	4,078,332,433	3,427,037,884	19.0	31.3
Paid for contract work	198,876,826	178,645,635	11.3	22.9
Rent and taxes (including internal revenue)	582,039,665	457,883,110	27.1	
Cost of materials	14,368,088,831	12,142,790,878	18.3	42.9
Value of products	24,246,434,724	20,672,051,870	17.3	39.7
Value added by manufacture (value of products less cost of materials)	9,878,345,893	8,529,260,992	15.8	35.5

[1] A minus sign (—) denotes decrease.

TABLE A.—GROWTH OF AMERICAN CHEMICAL INDUSTRIES 1909 TO 1914

Item	All Industries 1909	All Industries 1914	Chemical and Allied Products 1909	Chemical and Allied Products 1914	Per Cent Increase 1914 Over 1909 All Industries	Per Cent Increase 1914 Over 1909 Chemical and Allied Products	Per Cent of the Whole in Chemicals and Allied Products 1909	Per Cent of the Whole in Chemicals and Allied Products 1914	Per Cent Increase in 1914 Over 1909 of Per Cent of Whole in Chemical and Allied Products in 1909
1 No. of establishments	268,491	275,791	2,140	2,461	3	15	0.79	0.89	13
2 No. of wage earners (av.)	6,615,046	7,036,337	70,426	86,78888	6	23	1.06	1.23	16
3 Capital	$18,428,269,706	$22,790,979,937	$483,729,410	$722,989,000	24	49	2.62	3.17	21
7 Value Added by manufacture (Item 6 less Item 5)	8,530,261,000	9,878,345,893	166,968,565	206,864,000	16	24	1.96	2.10	7
Column	A	B	C	D	E	F	G	H	J

NOTE.—Percentages given above were obtained as follows: $E = \frac{(B-A) \times 100}{A}$; $F = \frac{(D-C) \times 100}{C}$; $G = \frac{C \times 100}{A}$; $H = \frac{D \times 100}{B}$; $J = \frac{(H-G \times 100}{G}$

TABLE 5

INDUSTRIES WITH GROSS VALUE OF PRODUCTS OF $100,000,000 OR MORE IN 1914

Industry	Wage Earners (Average Number) Rank, 1914	Wage Earners (Average Number) Per Cent of Increase[1] 1909–1914	Wage Earners (Average Number) Per Cent of Increase[1] 1904–1909	Cost of Materials Rank, 1914	Cost of Materials Per Cent of Increase[1] 1909–1914	Cost of Materials Per Cent of Increase[1] 1904–1909	Value of Products Rank, 1914	Value of Products Per Cent of Increase[1] 1909–1914	Value of Products Per Cent of Increase[1] 1904–1909	Value Added by Manufacture Rank, 1914	Value Added by Manufacture Per Cent of Increase[1] 1909–1914	Value Added by Manufacture Per Cent of Increase[1] 1904–1909
All industries	....	6.4	21.0	....	18.3	42.9	....	17.3	39.7	....	15.8	35.5
Industries with products valued at $500,000,000 or over												
Slaughtering and meat packing	19	12.5	18.5	1	21.0	47.8	1	21.9	48.3	13	28.2	51.9
Iron and steel, steel works and rolling mills	5	3.6	15.7	3	—10.1	49.0	2	—6.8	46.3	4	—0.1	41.0
Flour-mill and gristmill products	42	0.7	0.9	2	—2.0	23.8	3	—0.7	23.9	21	8.1	24.7
Foundry and machine-shop products	3	.....	.....	6	.....	.....	4	.....	.....	1	.....	.....
Lumber and timber products	1	—12.3	35.3	11	6.2	44.6	5	—5.1	29.9	2	—11.2	23.2
Cotton goods	2	2.2	19.6	4	18.6	29.1	6	10.0	39.0	7	—2.5	56.6
Cars and general shop construction and repairs by steam-railroad companies	4	20.3	19.1	17	22.3	32.0	7	26.7	30.9	6	31.1	29.9
Automobiles	22	54.6	401.0	9	171.6	824.1	8	159.6	627.4	12	144.7	474.4
Boots and shoes, not including rubber boots and shoes	6	3.5	23.5	8	11.9	40.6	9	13.4	38.3	14	15.9	34.6
Industries with products valued at $100,000,000, but less than $500,000,000,												
Printing and publishing, newspaper and periodicals	15	5.2	12.2	31	32.6	38.4	10	22.1	31.3	3	18.8	29.2
Bread and other bakery products	13	23.8	23.3	12	15.2	52.6	11	23.9	47.2	10	37.0	39.8
Clothing, women's	8	9.9	32.9	15	20.9	59.7	12	23.2	55.4	9	25.9	50.5
Clothing, men's	7	—9.1	39.4	18	—8.9	35.9	13	—5.7	36.5	8	—2.1	37.1
Smelting and refining, copper	74	13.5	22.6	5	13.7	69.5	14	17.2	57.3	40	43.3	2.8
Liquors, malt	24	13.7	13.4	30	34.3	29.0	15	18.0	25.6	5	12.3	24.5
Petroleum, refining	59	82.1	—16.9	7	63.2	43.0	16	67.2	35.4	33	88.5	5.9
Woolen and worsted goods	9	—2.8	14.9	16	—9.9	38.5	17	—9.6	36.3	20	—9.1	32.5
Leather, tanned, curried, and finished	25	—10.1	8.7	10	14.5	29.9	18	12.0	29.8	30	4.2	29.5
Electrical machinery, apparatus, and supplies	14	35.3	44.3	23	42.5	62.4	19	51.4	57.2	16	60.0	52.4
Paper and wood pulp	21	16.4	15.2	19	28.9	48.7	20	24.1	41.8	23	16.4	32.0
Iron and steel, blast furnaces	50	—23.6	9.6	13	—17.5	79.2	21	—18.8	68.8	44	—25.0	33.9
Tobacco, cigars and cigarettes	10	9.5	3.1	29	27.1	26.6	22	21.1	21.3	15	17.1	18.1
Lumber, planing-mill products	20	.....	.....	21	.....	.....	23	.....	.....	22	.....	.....
Printing and publishing, book and job	16	4.1	23.9	39	24.2	47.7	24	22.5	37.4	11	21.7	33.3
Sugar, refining	101	19.7	.....	14	16.7	.....	25	16.4	.....	75	13.3	.....
Furniture	12	3.6	12.1	33	17.0	41.1	26	15.9	34.5	18	15.1	29.4
Hosiery and knit goods	11	16.4	24.2	26	33.1	43.6	27	29.4	46.0	24	24.8	49.1
Silk goods, including throwsters	17	9.2	24.4	27	34.0	42.1	28	29.0	47.7	25	22.9	55.2
Butter	87	22.4	21.3	20	25.3	67.5	29	24.8	64.5	68	21.6	47.1
Rubber goods, not elsewhere specified	31	89.4	25.2	32	53.4	111.2	30	74.1	103.9	27	110.8	92.0
Gas, illuminating and heating	38	17.7	21.8	43	41.0	41.0	31	32.0	33.3	19	25.4	30.0
Food preparations, not elsewhere specified	70	35.7	32.1	25	83.2	122.8	32	75.0	104.9	39	58.5	76.0
Oil, cottonseed, and cake	65	27.8	9.9	22	51.0	49.7	33	43.5	53.4	67	11.1	71.2
Liquors, distilled	155	—2.1	20.1	68	14.0	40.4	34	1.0	55.9	17	—1.7	59.7
Cars, steam-railroad, not including operations of railroad companies	27	26.0	26.5	28	67.9	4.1	35	57.4	11.3	41	39.1	26.6
Tobacco, chewing and smoking, and snuff	58	—4.6	13.5	44	2.9	65.6	6	11.9	34.1	26	20.1	14.4
Smelting and refining, lead	137	—0.5	—2.0	24	1.4	—10.1	37	2.5	—9.9	98	13.7	—8.5
Confectionery	28	20.2	23.2	38	24.5	66.3	38	26.7	54.8	34	30.2	40.2
Agricultural implements	33	—4.1	6.7	45	21.9	24.9	39	12.1	30.6	29	5.3	35.0
Brass, bronze, and copper products	41	—0.8	22.5	35	16.4	51.1	40	8.1	46.5	47	—8.0	38.1
Structural ironwork, not made in steel works or rolling mills	35	17.2	17.4	42	14.3	61.6	41	19.6	46.5	32	26.8	30.1
Chemicals	46	36.2	19.6	40	39.4	52.4	42	34.2	56.2	36	28.0	61.1
Fertilizers	62	24.6	29.1	36	55.3	77.0	43	47.4	83.9	49	31.4	99.6
Coffee and spice, roasting and grinding	126	14.1	25.7	34	40.0	26.4	44	36.4	31.3	62	25.3	49.0
Canning and preserving, fruits and vegetables	30	24.3	1.3	37	65.2	21.2	45	63.1	17.0	48	58.8	8.8
Brick and tile, terra-cotta, and fire-clay products	18	.....	.....	65	.....	.....	46	.....	.....	28	.....	.....
Automobile bodies and parts	34	95.6	1,249.6	49	166.0	1,501.5	47	134.0	1,534.3	38	109.7	1,560.2
Soap	86	9.0	17.7	41	23.1	65.5	48	14.9	63.1	58	—0.3	58.9
Glass	23	8.1	7.7	63	43.3	22.8	49	33.6	15.7	31	28.5	12.2
Millinery and lace goods	37	15.5	42.5	51	28.1	71.5	50	32.9	69.2	42	38.3	66.6
Paints	89	12.5	21.3	46	14.6	34.9	51	18.9	40.6	56	27.1	53.1
Dyeing and finishing textiles	32	10.0	23.8	52	60.8	79.7	52	30.8	64.3	45	8.9	54.6
Marble and stone work	26	—16.2	28.4	74	1.1	40.8	53	—5.3	33.3	35	—8.5	29.9
Carriages and wagons	39	—21.4	—13.5	57	—18.3	4.4	54	—14.9	(2)	43	—11.3	—4.1
Patent medicines and compounds	90	20.8	0.5	76	33.6	26.3	55	22.3	12.4	37	17.0	6.9
Cement	54	4.3	53.2	58	77.2	104.2	56	61.0	111.6	46	47.0	91.8

[1] A minus sign (—) denotes decrease. [2] Less than one-tenth of 1 per cent.

TABLE 6.

SUMMARY FOR FOURTEEN GENERAL GROUPS OF INDUSTRIES: 1914, 1909, 1904, AND 1899

Group	Census Year	Number of Establishments	Wage Earners (Average Number)	Capital	Wages	Cost of Materials	Value of Products	Value Added by Manufacture
				Expressed in Thousands				
All industries	1914	275,791	7,036,337	$22,790,980	$4,078,332	$13,368,089	$24,246,435	$9,878,346
	1909	268,491	6,615,046	18,428,270	3,427,038	12,142,791	20,672,052	8,529,261
	1904	216,180	5,468,383	12,675,383	2,610,445	8,500,208	14,793,903	6,293,695
	1899	207,514	4,712,763	8,975,256	2,008,361	6,575,851	11,406,927	4,831,076
Chemicals and allied products	1914	12,374	299,569	3,034,209	167,494	1,289,348	2,001,634	712,286
	1909	12,060	267,261	2,167,425	129,003	931,045	1,526,599	595,554
	1904	9,826	227,326	1,588,328	102,388	633,919	1,075,519	441,600
	1899	8,928	196,538	1,163,816	77,560	451,457	761,691	310,234

The 344 industries distinguished in the census of 1914 have been grouped into 14 general classes in order to facilitate comparison of one broad type with another. In Table 6 are given the figures for "all industries" and the group of "chemicals and allied products" for four census periods. In general the reader will observe in the chemical group a marked difference between the figures of the first two and last two periods, showing increases in the latter of 50 to 100 per cent or more. Thus, the number of establishments increased from 8928 in 1899 to 12,374 in 1914. Capital invested increased more than 100 per cent; cost of materials nearly 300 per cent; value of products nearly 300 per cent; and value added by manufacture over 200 per cent.

TABLE 106

Industry	Number of Establishments	Wage Earners (Average Number)	Chemicals and Allied Products: 1914 — Capital	Wages	Cost of Materials	Value of Products	Value Added by Manufacture
			Expressed in thousands				
Total	12,374	299,569	$3,034,209	$167,494	$1,289,348	$2,001,634	$712,286
Baking powders and yeast	124	2,270	35,272	1,241	10,895	22,339	11,444
Baking powders	105	1,606	28,375	771	8,427	16,003	7,576
Yeast	19	664	6,897	470	2,468	6,336	3,868
Blacking, stains and dressings	197	1,766	4,986	877	5,129	9,882	4,753
Bluing	66	254	712	105	489	1,184	695
Bone, carbon and lamp black	27	339	4,995	231	686	1,464	778
Bone black and lamp black	7	164	656	114	263	535	272
Carbon black	20	175	4,339	117	423	929	506
Candles	15	387	2,286	183	1,119	1,731	612
Chemicals and acids	427	35,375	259,580	24,279	96,185	173,269	77,084
Chemicals	395	32,311	224,346	22,066	89,451	158,054	68,603
Sulphuric, nitric and mixed acids	32	3,064	35,234	2,213	6,734	15,215	8,481
Cleansing and polishing preparations	398	1,239	5,898	619	3,895	9,152	5,257
Cleansing preparations	186	601	3,013	296	2,047	5,045	2,998
Polishing preparations	212	638	2,885	323	1,848	4,107	2,259
Coke, not including gas-house coke	231	21,107	161,561	14,289	69,138	99,275	30,137
Drugs, etc	3,844	26,561	136,156	13,293	71,555	175,452	103,897
Drug grinding	29	1,059	8,434	583	5,215	8,080	2,865
Druggists' preparations	416	9,277	46,638	4,755	22,935	48,010	25,075
Patent medicines and compounds	2,903	13,328	71,437	6,675	35,940	102,463	66,523
Perfumery and cosmetics	496	2,897	9,647	1,280	7,465	16,899	9,434
Dyestuffs and extracts	112	2,839	21,284	1,613	13,238	20,620	7,382
Explosives	111	6,306	71,351	4,488	25,627	41,433	15,806
Fertilizers	784	22,815	217,065	10,532	107,955	153,196	45,241
Gas, illuminating and heating	1,284	43,792	1,252,422	26,802	76,799	220,238	143,459
Glue, not elsewhere specified	57	3,129	17,162	1,854	9,368	13,733	4,365
Greases	446	5,582	22,368	3,794	19,828	29,820	9,992
Grease and tallow, not including lubricating greases	369	5,106	18,928	3,512	17,061	24,901	7,840
Soap stock	107	1,877	6,993	1,223	5,407	8,087	2,680
Tallow	180	1,750	7,157	1,249	8,412	11,389	2,977
All other	82	1,479	4,778	1,040	3,242	5,425	2,183
Lubricating greases	77	476	3,440	282	2,767	4,919	2,152
Ink, printing	70	1,391	11,943	1,064	6,806	13,830	7,024
Ink, writing	54	512	2,464	263	1,236	2,784	1,548
Oils	1,193	25,596	187,193	11,113	248,517	90'040	48,846
Cottonseed and cake	882	21,810	18,073	8,490	1180,977	212,127	31,150
Essential	105	249	1,617	133	1,565	2,314	749
Linseed	25	1,488	39,873	1,127	39,555	44,882	5,327
Not elsewhere specified	181	2,049	27,630	1,363	26,420	38,040	11,620
Fish	22	420	4,362	217	3,470	4,370	900
Oleo	5	248	837	171	1,807	2,295	488
All other	154	1,381	22,431	975	21,143	31,375	10,232
Paint and varnish	800	16,083	129,534	10,180	88,466	145,624	57,158
Paints	585	13,349	99,673	8,315	71,588	112,409	40,821
Varnishes	215	2,734	29,861	1,865	16,878	33,215	16,337
Petroleum, refining	176	25,366	325,646	19,397	325,265	396,361	71,096
Salt	98	5,089	33,151	3,041	6,273	14,070	7,797
Soap	371	14,172	92,872	8,088	88,867	127,942	39,075
Turpentine and rosin	1,394	34,817	20,745	8,583	5,536	20,990	15,454
Wood distillation, not including turpentine and rosin	93	2,782	17,563	1,565	6,496	9,882	3,386

Scope of the Census

As might easily be imagined, the officials in charge of the census are somewhat puzzled as to just what industries should be grouped in chemicals and allied products. Of necessity the decision must be more or less arbitrary, and as shown in Table 106 the group includes "not only the industries whose products are chemicals in the ordinary sense of that term, but also the industries which employ to a large extent chemical processes of manufacture." Table 106, in effect, is a detailed analysis of the summary figures for 1914 given in Table 6. The census did not cover establishments which were idle during the year or those which had a value of products of less than $500; nor did it cover the manufacturing, if any, done in educational, eleemosynary and penal institutions.

Baking Powders and Yeast

This classification includes various compounds for raising bread, cake, and pastry, and dry, compressed, and liquid yeast. Table 106 shows separate statistics for the establishments whose chief product was baking powders and for those making yeast as the product of chief value. Many minor products were reported by the manufacturers of baking powder, such as bluing, chocolate, coffee, spice, confectionery, flavoring extracts, food preparations, and vinegar; while those making yeast also reported stock feed and alcohol.

In addition to the products covered by Table 106 baking powders to the value of $1,867,674 were reported in 1914 as made for sale by establishments assigned to other industries, principally those grinding and roasting coffee and those manufacturing flavoring extracts. Yeast to the value of $2,451,440 was reported as sold by distillers and manufacturers of vinegar. In 1909 baking powders and yeast to the value of $3,963,573 were reported by establishments assigned to other industries. Many concerns make similar products for their own consumption in further processes of manufacture.

Blacking, Stains, and Dressings

Establishments in this industry manufacture principally blackings, waxes, stains, dressings, and polishes

for leather boots and shoes, harness and belting, stove polish, burnishing inks, and enameled carriage-top dressings, as well as pastes, washes, dyes, and gums.

In addition to the products covered by Table 106 blackings, stains and dressings to the value of $377,617 in 1914 were reported by establishments assigned to other classifications, principally "mucilage and paste," "paints," "patent medicines and compounds," and "leather, tanned, curried, and finished."

Bluing

Establishments under this classification manufacture principally laundry bluing, soluble or liquid, aniline blue etc. The usual materials used in this manufacture are indigo and Prussian blue.

In addition to the products covered by Table 106 bluing to the value of $269,199 in 1914 and of $350,377 in 1909 was reported by establishments assigned to other classifications, principally "pickles, preserves, and sauces," "flavoring extracts," "patent medicines and compounds," and "coffee and spice, roasting and grinding."

Bone, Carbon and Lampblack

Establishments in this classification are engaged in the preparation of black pigments. There are three principal methods: The carbonization of bones in retorts, producing bone black or animal charcoal, also known technically as "char"; the deposition of carbon black by the imperfect combustion of natural gas, the flame impinging upon slate or metallic slabs or revolving cylinders; and the deposition of lampblack by the incomplete combustion of coal tar, wood tar, petroleum, rosin etc., the dense smoke depositing the soot in chambers. Some establishments make ivory black by the carbonization of scraps of animal teeth and tusks.

Table 106 shows statistics for "bone black and lampblack" and for "carbon black" separately, each establishment being classified according to its product of chief value. Table 107 presents the statistics of the production of bone black, carbon black, and lampblack by establishments in all industries for 1914 and 1909.

TABLE 107

	Bone, Carbon and Lamp Black	
	1914	1909
Total number of establishments	39	57
Total value of products	$2,953,947	$2,135,554
Products		
Bone black (animal charcoal):		
Number of establishments	7	7
Pounds	44,509,000	
Value	$1,532,000	$1,070,333
Carbon black:		
Number of establishments	20	18
Pounds	22,869,000	
Value	$918,091	$625,514
Lampblack:		
Number of establishments	12	32
Value	[1]$503,856	$439,707

[1] Includes $215,212, the value of 4,786,394 pounds, and $288,644 for which no quantity was reported.

Candles

The principal products of establishments under this classification are candles of all descriptions made of tallow, paraffin, stearin, and wax. In addition to the products covered by Table 106 candles were reported in 1914 by petroleum refineries to the value of $1,402,945 and by soap manufacturers to the value of $150,492, while establishments assigned to other classifications, principally chemicals, reported candles to the value of $411,631. The candles made by petroleum refineries were not reported separately in 1909, and the amount cannot be stated, but candles to the value of $527,910 were reported by establishments engaged primarily in the manufacture of "soap," "chemicals" and "oil, not elsewhere specified."

Chemicals and Acids

Prior to the census of 1904 the general statistics for chemicals, sulphuric, nitric, and mixed acids, and wood distillation were included under the single classification of "Chemicals." For the censuses of 1904, 1909, and 1914, the three have been shown separately and a segregation of data made for 1899 for comparison. The statistics for wood distillation products are given in Table 122.

TABLE 122

WOOD DISTILLATION

	1914	1909
Number of establishments	101	136
Wood distillation industry	95	120
Manufacturing subsidiary wood disitillaon products	6	16
Number producing crude alcohol	80	98
Number producing refined alcohol	16	17
Number distilling pine wood	15	33
Wood, cords	1,042,517	[1]1,265,157
Hardwoods	970,308	1,149,847
Pine	72,209	115,310
Crude wood alcohol:		
Consumed, gallons	7,388,902	9,670,497
Purchased—		
Gallons	5,565,446	7,135,614
Cost	$1,408,124	$1,784,029
Made and consumed, gallons	1,823,456	2,534,883
Products		
Total value	$10,529,829	$10,312,657
Wood distillation industry	$9,882,537	$9,736,998
Subsidiary products, other industries	$647,292	$575,659
Wood alcohol:		
Crude, gallons	9,020,431	9,307,583
For sale—		
Gallons	7,196,975	6,772,700
Value	$1,605,880	$1,774,459
Made and consumed, gallons	1,823,456	2,534,883
Refined, gallons	6,464,955	.....
For sale—		
Gallons	6,235,113	6,732,877
Value	$2,709,369	$3,096,808
Made and consumed, gallons	229,842	([2])
Acetate of lime, pounds	[3]166,084,523	.....
For sale—		
Pounds	163,521,577	141,478,296
Value	$2,138,909	$2,118,443
Made and consumed, pounds	2,562,946	([2])
Turpentine:		
Gallons	[4]575,557	706,868
Value	$194,183	$249,526
Tar, gallons	2,794,881	.....
For sale—		
Gallons	1,306,324	1,570,257
Value	$174,154	$113,225
Made and consumed, gallons	1,488,557	([2])
Wood creosote:		
Pounds	2,073,057	2,549,190
Value	$38,872	$34,645
Charcoal:		
Bushels	44,450,485	39,952,235
Value	[5]$2,801,401	$2,426,648
Rosin:		
Barrels	[4]51,825	([2])
Value	$198,165	.....
Other wood distillation products	[6]$441,399	$231,192
All other products	$227,497	$267,711

DISTILLATION EQUIPMENT

Aggregate capacity, cords	26,707	24,594
Retorts:		
Number	794	1,448
Capacity, cords	1,850	2,703
Ovens:[7]		
Number	228	177
Capacity, cords	1,717	1,080
Kilns:		
Number	326	310
Capacity, cords	23,140	20,811

[1] Forest Products of the United States, 1909, p. 163; includes some wood used in charcoal burning.
[2] Figures not available.
[3] Total production of acetate of lime.
[4] Total production of turpentine and rosin, all industries; turpentine, 27,648,939 gallons; rosin, 2,944,929 barrels.
[5] Total value of products of the charcoal industry and of charcoal made for sale in other industries, $3,209,628.
[6] Includes acetic acid, acetate of soda, acetone, formaldehyde, pyrolignite of iron, and wood ashes. Total production for sale by all industries, of acetone, 10,425,817 pounds, value $1,090,585; acetic acid, 70,617,637 pounds, value $1,272,294; formaldehyde, 8,426,247 pounds, value $655,174.
[7] In some cases equipment was reported as retorts at one census and ovens at another census.

Although the manufacture of sulphuric, nitric, and mixed acids is in the main a specialized industry, there is a considerable production by establishments that also manufacture other chemicals, and a large quantity of sulphuric acid is made in conjunction with the fertilizer industry. Hence, in Table 106, which presents in detail the statistics for materials and products for 1914 in comparison with those for 1909, 1904, and 1899, the statistics for sulphuric, nitric, and mixed acids are included along with those for other acids. At prior censuses establishments engaged in the manufacture of supplies for calcium lights, chiefly lime cylinders, and oxygen gas, constituted a separate industry, but these are now included under chemicals.

The chemical products are classified under 12 groups: (1) acids; (2) sodas and sodium compounds; (3) potash and potassium salts; (4) alums; (5) coal-tar products; (6) cyanides; (7) bleaching materials; (8) chemical substances produced by the aid of electricity, including those belonging under other groups; (9) plastics; (10) compressed or liquified gases; (11) fine chemicals; and (12) chemicals, not otherwise specified, such as glycerin, cream of tartar, epsom salts, blue vitriol, copperas etc.

The schedule used in taking the census named, under the various groups, the chemicals which at prior censuses had been reported by three or more establishments, and provided for the reporting in detail of such other chemicals as were manufactured. In some cases, however, manufacturers did not separately report all products, consequently there results a large amount of unclassified chemicals, which may include a considerable production of some of those for which detail figures are given and undoubtedly include others which could have been shown if they had been separately reported. The production is shown for all chemicals that can be separately given without the disclosure of individual operations, and those separately returned, but which can not be individually given, are named and reported as a whole under the several groups.

Many establishments distilling coal tar consume part of the product in the manufacture of roofing paper, roofing felt etc., and hence are classified as engaged in other industries, and their coal-tar production is not included under Group 5. Except as stated, where the production made and consumed is given, the figures refer to the quantity and value of the product made for sale and do not include that made and consumed in the same plant.

With respect to the group of products produced by the aid of electricity (Group 8) it should be said that many of the electrochemical and electrometallurgical products have, until recent years, been under the protection of patents, and detail statistics of production cannot be given for some of the most important without disclosing the operations of individual establishments.

Under plastics (Group 9) there is included pyroxylin plastics, sold under such trade names as celluloid, fiberloid, viscoloid, pegamoid, pyrolin, xylonite etc.; pyroxylin or soluble cotton; viscose; artificial silk; phenolic condensation plastics, such as bakelite and condensite; rubber substitutes and all plastics formed by using caoutchouc, gutta-percha, casein, fibrin, gluten, gums, and glue, or other cementing materials by which sawdust, woodpulp, bonedust, zinc oxide, antimony, kaolin,

TABLE 108

THE CHEMICAL INDUSTRY, INCLUDING SULPHURIC, NITRIC, AN MIXED ACIDS (TONS OF 2,000 POUNDS)

		1914	1909
Number of establishments		754	850
The chemical industry		395	359
Sulphuric, nitric, and mixed-acids industry		32[illegible]	42
Manufacturing subsidiary chemical products		327[illegible]	449
Materials[2]			
Total cost		$96,185,122	$69,531,257
The chemical industry		$89,450,694	$64,145,429
Sulphuric, nitric, and mixed-acids industry		$6,734,428	$5,385,828
Sulphur or brimstone:			
Tons		56,296	77,450
Cost		$1,162,632	$1,433,743
Pyrites:			
Tons		889,695	597,691
Cost		$3,769,467	$3,170,188
Nitrate of soda:			
Tons		58,101	52,976
Cost		$2,696,172	$2,373,220
Sulphuric acid:			
Tons		264,774	58,552
Cost		$1,515,982	$564,390
Nitric acid:			
Tons		7,819	1,525
Cost		$641,405	$139,591
Mixed acid:			
Tons		6,015	4,546
Cost		$698,664	$335,672
Ammonium sulphate:			
Tons		9,586	1,675
Cost		$567,249	$88,013
Alcohol:			
Grain—			
Gallons		296,886	479,428
Cost		$145,066	$287,416
Wood—			
Gallons		1,464,273	949,212
Cost		$577,122	$370,017
Fuel and rent of power		$11,854,901	$8,566,924
All other materials		$72,556,462	$52,202,083
Products			
Total value		$200,195,835	$150,580,149
The chemical industry, all products		$158,053,602	$117,741,103
Sulphuric, nitric, and mixed acid industry, all products		15,215,474	9,884,057
Subsidiary chemical products of other industries		26,926,759	22,954,989
I.—Acids			
Total value		$30,516,569	$23,722,874
Sulphuric acid:			
Number of establishments		194	183
Production reduced to 50° Baumé acid—			
Total tons		4,047,982	[3]2,764,455
For sale	tons	2,338,284	1,479,200
	value	$15,395,133	$10,103,425
Made and consumed, tons		1,709,698	1,285,255
Production according to strength—			
50° Baumé—			
Total, tons		1,677,649	1,643,281
For sale	tons	451,121	528,263
	value	$2,709,350	$3,176,430
Made and consumed, tons		1,226,528	1,115,018
60° Baumé—			
Total, tons		795,489	189,384
For sale	tons	545,562	177,414
	value	$3,754,866	$1,038,358
Made and consumed, tons		249,927	11,970
66° Baumé—			
Total, tons		828,466	552,619
For sale	tons	732,186	453,370
	value	$8,042,422	$5,454,002
Made and consumed, tons		96,280	99,249
Oleum or fuming, and sulphur trioxide—			
Total, tons		77,758	32,337
For sale	tons	[4]62,354	[4]28,594
	value	$888,495	$434,635
Made and consumed, tons		15,404	3,743
Reclaimed acid:			
Tons		136,360	7,069
Value		$518,890	$62,935
Nitric acid:			
Number of establishments		52	25
Total production, tons		78,589	[3]68,717
For sale	tons	14,685	13,663
	value	$1,591,625	$1,357,098
Made and consumed, tons		63,904	55,054
Mixed acid (sulphuric-nitric):			
Number of establishments		37	14
Total productions, tons		112,124	.....
For sale	tons	42,725	[3]28,591
	value	$2,204,480	$1,860,787
Made and consumed, tons		69,399	(1)
Acetic acid:			
Number of establishments		13	13
Total production, pounds		75,303,375	[3]58,000,602
For sale	pounds	70,617,637	56,923,773
	value	$1,272,294	$1,336,874
Made and consumed, pounds		4,685,738	1,076,829

[1] Figures not available.
[2] Does not include materials used in chemical manufacture by establishments producing chemicals as subsidiary products.
[3] See Note 6.
[4] Includes oleum, in 1914, 60,963 tons; and in 1909, 27,602 tons, converted, above, to 50° acid at 1.71; and sulphur trioxide, in 1914, 1,391 tons; and in 1909 992 tons, converted, above, to 50° acid at 1.93.

TABLE 108 (Continued)

Products		1914	1909
I.—*Acids* (Continued)			
Boric acid:			
Number of establishments		5	5
Total production, pounds		8,590,311	
For sale	pounds	8,584,311	5,554,914
	value	$588,981	$295,776
Made and consumed, pounds		6,000	[1]
Citric acid:			
Number of establishments		3	5
Total production, pounds		2,729,943	
For sale	pounds	2,657,840	2,102,256
	value	$1,516,336	$777,235
Made and consumed, pounds		72,103	[1]
Hydrofluoric acid:			
Number of establishments		9	10
Total production, pounds		7,209,248	8,027,290
For sale	pounds	5,373,657	6,842,914
	value	$325,540	$294,379
Made and consumed, pounds		1,835,591	1,184,376
Muriatic acid:			
Number of establishments		31	38
Total production, pounds		337,167,882	[2]244,734,217
For sale	pounds	170,876,878	203,214,879
	value	$1,348,805	$1,758,335
Made and consumed, pounds		166,291,004	41,519,338
Oleic acid:			
Number of establishments		7	8
Total production, pounds		23,187,579	
For sale	pounds	21,932,736	16,377,063
	value	$1,301,353	$845,106
Made and consumed, pounds		1,254,843	[1]
Phosphoric acid:			
Number of establishments		7	9
Production for sale—			
Pounds		12,420,191	[1]
Value		$680,239	$667,505
Stearic acid:			
Number of establishments		10	11
Total production, pounds		14,960,109	
For sale	pounds	14,351,404	[1]
	value	$1,242,492	$1,143,213
Made and consumed, pounds		608,705	[1]
Tannic acid:			
Number of establishments		5	
Production for sale—			
Pounds		853,830	
Value		$287,142	[3]$3,220,206
Fatty acids		$206,576	
Miscellaneous acids[7]		$1,977,131	
Unclassified acids		$59,552	
II.—Sodas and sodium compounds			
Sodas:			
Number of establishments[8]		69	70
Value		$23,632,704	$23,368,509
Bicarbonate of soda—			
Tons		90,169	82,800
Value		$1,439,014	$1,515,945
Caustic soda—			
Tons		212,539	131,612
Value		$6,657,514	$5,264,887
Sal soda, including monohydrate crystals—			
Tons		106,591	86,644
Value		$1,510,449	$1,156,882
Soda ash—			
Tons		935,305	646,057
Value		$10,937,945	$10,362,656
Borax—			
Tons		26,501	20,154
Value		$2,071,774	$1,756,922
Soda products not classified		$1,016,008	$3,312,117
Sodium:			
Phosphate—			
Tons		15,397	12,290
Value		$853,528	$540,282
Silicate—			
Tons		169,049	34,170
Value		$1,648,854	$366,621
Sulphides—			
Tons		20,263	7,673
Value		$516,644	$206,450
Sulphate—			
Glauber salts—			
Tons		34,537	46,471
Value		$427,808	$512,464
Salt cake—			
Tons		90,442	[1]
Value		$841,887	
Bichromate—			
Tons		11,824	[1]
Value		$1,125,398	
Benzoate		$61,490	[1]
Sulphite		$66,649	[1]
Other sodium compounds		[9]$768,157	[1]
Lye		$2,447,406	[1]
Soda washing compounds, not including soap—			
Tons		12,441	[1]
Value		$204,230	
III.—Potash and potassium salts.			
Number of establishments		42	31
Products, value		$4,094,927	
Crude potash		$30,644	$88,940
Potassium carbonate (unrefined and refined)		$19,007	

[6] Includes considerable quantities of the acids for which statistics are given above, notably sulphuric, nitric, mixed, acetic and muriatic acids, which a few establishments reported in lump without classification according to kind.

[7] Includes the following acids, in order named as to value: Tartaric, carbolic picric, salicylic, lactic, oxalic, hydrofluosilicic, pyrogallic, gallic, pyroligneous hypophosphorus, benzoic and arsenic.

[8] Number manufacturing bicarbonate, caustic, sal soda, soda ash or borax in 1914 and 1909; and same not including borax in 1904 and 1899.

[9] Includes the following sodium compounds in order named as to value: Hyposulphite, sesquicarbonate, acetate, nitrate, perborate, bromide, iodide, fluoride, bisulphate, citrate, diamide and oxalate.

Products		1914	1909
III.—*Potash and Potassium Salts* (Continued)			
Potassium nitrate (saltpeter):			
Tons		14,740	[1]
Value		$1,244,051	
Caustic potash and potassium salts—bicarbonate, chlorate, iodide, citrate, acetate, silicate, etc.		$2,801,225	[1]
IV.—Alums			
Number of establishments		19	19
Pounds		313,712,000	276,294,000
Value		$3,467,969	$3,022,355
Aluminum sulphate:			
Pounds		142,438,000	100,595,000
Value		$1,277,836	$843,956
Alum cake:			
Pounds		23,338,000	27,001,000
Value		$251,186	$274,307
Concentrated alum:			
Pounds		42,562,000	54,879,000
Value		$450,730	$468,795
Burnt alum:			
Pounds		22,629,000	11,746,000
Value		$364,656	$209,904
Potash alum:			
Pounds		12,765,000	10,254,00
Value		$219,968	$155,31
Soda alum:			
Pounds		[10]13,995,000	[10]8,062,00
Value		$254,477	$133,941
Other alums—porous, excelsior, pearl, ammonium, chloride of alumina, etc.:			
Pounds		55,985,000	[11]63,757,
Value		$649,116	$936,
V.—Coal-tar product			
Number of establishments		40	
Coal-tar distillery products, value		[12]$8,065,156	$4,057,
Chemicals or medicinal preparations from coal-tar, value		$774,350	$228,5
VI.—Cyanides			
Number of establishments		6	
Pounds		[13]16,450,225	13,291,
Value		$2,398,674	$1,941,8
Yellow prussiate of potash:			
Pounds		3,204,684	3,510,208
Value		$451,092	$463,983
All other—sodium cyanide, metallocyanides, yellow prussiate of soda, trisalytes, and potassium cyanide:			
Pounds		13,245,541	9,780,872
Value		$1,947,582	$1,477,910
VII.—Bleaching materials			
Number of establishments		56	48
Value of products		$5,302,359	$3,215,728
Hypochlorites—chiefly chloride of lime and bleaching powder:			
Number of establishments		14	9
Pounds		310,380,000	116,802,000
Value		$2,916,225	$1,786,846
Hydrogen peroxide:			
Number of establishments		20	17
Pounds		[14]32,595,000	[14]9,926,000
Value		$1,303,596	$870,541
Bisulphite of soda, lime, etc.:			
Number of establishments		14	15
Pounds		26,346,000	31,718,000
Value		$243,559	$226,154
Chlorine:			
Number of establishments		7	
Pounds		12,217,000	
Value		$472,836	$332,187
All other—sodium peroxide, sulphur dioxide, lime sulphur solutions, etc.		$366,143	
VIII.—Chemical substances produced by the aid of electricity[15]			
Number of establishments		36	[16]34
Value of products		$29,661,949	$18,451,461
Chlorates:			
Number of establishments		5	5
Tons		8,304	5,785
Value		$1,131,316	$904,550
Hypochlorites:			
Number of establishments		4	5
Tons		73,197	45,976
Value		$1,714,837	$1,506,831
Caustic soda, caustic potash, and lye:			
Number of establishments		6	
Tons		48,663	
Value		$2,309,811	
Ferro and other alloys[17]:			
Number of establishments		7	
Value		$2,859,482	

[10] Includes sodium aluminum sulphate.

[11] Includes 38,342,000 pounds of unclassified alums.

[12] Not including value of 109,901,315 gallons of tar, $2,867,274, produced by by-product coke ovens; of 125,938,607 gallons of tar, $3,252,756, produced by gas plants; and of coal-tar dyes and intermediates, $4,652,947, made largely from stock of foreign origin.

[13] In addition, 1,239,382 pounds of cyanide blues, reported as Prussian blue, valued at $387,077, were manufactured by 15 establishments engaged primarily in the manufacture of paints and pigments.

[14] Quantities not comparable because of lack of uniformity in strength of solutions.

[15] The statistics for products reported under other groups cover total production, inclusive of that made with the aid of electricity, and here included to the value of $5,047,281 in 1914, and $2,539,478 in 1909.

[16] Includes number and output of one establishment engaged in the preparation of alumina.

[17] In addition, there were made in electric furnaces in 1914 by 14 establishments in the iron and steel industry, 21,548 tons of foundry iron and steel ingots and castings, chiefly direct steel castings.

TABLE 108 (Continued)

Products	1914	1909
VIII.—*Chemical Substances Produced by the Aid of Electricity* (Continued)		
Oxygen and hydrogen:		$16,040,080
Number of establishments	5	
Value	$68,441	
All other, named in order of value—aluminum, calcium carbide, abrasives, electrodes, sodium and sodium peroxide, phosphorus, silicon, chlorine, carbon bisulphide, and muriatic acid	$21,578,062	
IX.—Plastics		
Number of establishments	24	24
Value of products	$13,895,784	$7,472,732
Pyroxylin, including goods sold under trade names—celluloid, fiberloid, viscoloid, xylonite, etc.	$8,876,509	$5,682,379
In partially manufactured form—rods, sheets, blocks, etc	$3,778,374	(1)
Finished goods, manufactured in the producing establishments	$5,098,135	(1)
Rubber substitutes, including finished goods	$428,605	$1,790,353
Other plastics, including artificial silk	$4,590,670	
***X.—Compressed or liquefied gases*[18]**		
Total value	$7,624,884	$5,165,795
Anhydrous ammonia (NH_3):[19]		
Number of establishments	14	15
Pounds	16,659,789	11,969,846
Value	$3,140,848	$2,544,238
Carbonic acid gas, or carbon dioxide (CO_2):		
Number of establishments	38	35
Pounds	50,445,779	47,953,291
Value	$2,320,685	$2,345,743
Laughing gas, or nitrous oxide (N_2O):		
Number of establishments	7	5
Gallons	[20]17,838,000	[21]97,175
Value	$213,099	$38,589
Oxygen:		
Number of establishments	51	20
Cubic feet[22]	104,714,000	3,814,000
Value	$1,829,446	$177,469
Hydrogen:		
Number of establishments	6	
Cubic feet[22]	1,669,000	
Value	$16,671	$59,756
Other gases—Cyanogen, nitrogen and liquid air:		
Number of establishments	10	
Value	$104,135	
XI.—Fine chemicals		
Total value	$10,983,017	$10,267,252
Alkaloids:		
Ounces	5,805,212	3,482,617
Value	[23]$4,738,335	$3,188,914
Amylacetate:		
Pounds	1,300,052	1,470,568
Value	$465,664	$442,771
Chloroform:		
Pounds	1,333,954	1,869,685
Value	$295,317	$477,538
Ether:[24]		
Pounds	2,120,082	1,168,631
Value	$278,816	$190,164
Gold salts:		
Ounces	28,817	42,544
Value	$291,658	$430,944
Silver salts:		
Ounces	2,563,238	2,030,399
Value	$846,059	$727,428
Platinum salts:		
Ounces	365	1,561
Value	$6,998	$19,123
Thorium compounds, radium, uranium and vanadium	$1,388,477	
Vanillin:		
Pounds	120,619	
Value	$525,219	
Chemically pure (C. P.) preparations, including C. P. acids, alcohol, etc	$530,476	
Chemicals used in the manufacture of photographic materials, not otherwise specified	$121,690	$4,790,370
Other specified fine chemicals—Refined camphor, synthetic oils and perfumery bases, refined fusel oil, hypophosphites, ethyl chloride, sulphonmethane, and sulphon-ethylmethane, nicotine, and butyric ether (named in order of value)	$581,528	
All other fine chemicals, not reported separately	$912,780	
XII.—Chemicals, not otherwise specified.		
Total value	$47,597,084	$42,403,414
Acetone:		
Number of establishments	8	8
Pounds	10,425,817	7,761,696
Value	$1,099,585	$812,978

[18] For chlorine see "Bleaching materials."

[19] Not including anhydrous ammonia produced at by-product recovery coke ovens (mainly ammoniacal liquor sold on a pound basis of NH_3 content) as follows: In 1914, 25,370,509 pounds, valued at $2,300,137; in 1909, 4,871,014 pounds, valued at $448,455.

[20] Equivalent to 2,378,400 cubic feet at atmospheric pressure.

[21] Quantity reported in pounds.

[22] At atmospheric pressure.

[23] In addition, alkaloids and derivatives valued at $11,493,168 were reported by manufacturers of druggists' preparations and patent medicines.

[24] Not including ether made and consumed in the explosive industry.

Products	1914	1909
XII.—*Chemicals, Not Otherwise Specified* (Continued)		
Acetate of lime:		
Number of establishments	78	91
Pounds	163,522,000	141,478,001
Value	$2,138,909	$2,118,443
Ammonium salts:		
Chloride—		
Pounds	11,511,934	*
Value	$641,040	(1)
Sulphate—		
Pounds	8,846,616	
Value	$211,314	(1)
Other—Acetate, bifluoride, carbonate, phosphate, picrate, etc	$260,801	(1)
Aqua ammonia:[25]		
Pounds	35,544,246	20,983,476
Value	$1,412,236	$839,820
Barium salts:		
Sulphate (blanc fixé)—		
Pounds	18,278,000	8,152,000
Value	$257,415	$86,986
Other—Carbonate, chloride, etc	$103,204	(1)
Copper salts:		
Sulphate (blue vitriol)—		
Pounds	37,152,351	36,546,553
Value	$1,598,944	$1,531,574
Other	$14,383	(1)
Cream of tartar:		
Number of establishments	8	5
Pounds	12,646,120	15,592,937
Value	$3,124,958	$2,925,883
Epsom salts (magnesium sulphate):		
Number of establishments	12	10
Pounds	29,265,115	21,621,297
Value	$296,999	$189,791
Formaldehyde:		
Number of establishments	3	3
Pounds	8,426,247	3,794,486
Value	$655,174	$363,717
Glycerine:[26]		
Crude, for sale—		
Pounds	16,568,920	
Value	$2,278,976	
Refined, pounds	60,944,799	79,677,490
For sale (pounds)	59,810,405	$11,752,580
For sale (value)	$10,779,204	
Made and consumed, pounds	1,134,394	(1)
Iron salts:		
Sulphate (copperas)—		
Pounds	[27]92,478,823	[28]25,637,092
Value	$352,772	$78,467
Other salts and compounds—Iron liquor (ferrous acetate), chloride, nitrate, oxide, ferrotungsten, vanadate of iron, etc	$838,993	(1)
Lead salts:		
Arsenate—		
Number of establishments	11	
Pounds	8,641,856	(1)
Value	$511,688	
Other—		
Pounds	7,290,936	(1)
Value	$474,430	
Mercurial salts:		
Pounds	605,701	(1)
Value	$518,023	
Nickel salts:		
Pounds	409,548	(1)
Value	$157,149	
Niter cake:		
Number of establishments	31	24
Total production, tons	46,143	
For sale (tons)	24,129	27,546
For sale (value)	$31,580	$53,693
Made and consumed, tons	22,014	(1)
Sulphur, refined:		
Tons	[29]31,166	25,269
Value	$1,141,000	$891,501
Tin salts:		
Pounds	8,291,239	10,293,377
Value	$2,028,511	$1,535,350
Zinc salts:		
Pounds	40,786,886	25,054,213
Value	$1,130,959	$472,302
***XII.—Chemicals, not otherwise specified*—Con.**		
Other specified chemicals[30]	$3,055,314	$18,750,329
Unclassified chemicals	$12,483,523	
XIII.—All other products		
Chemical by-products and residues:		
Pyrite cinder	$399,458	$325,632
All other	$4,010,162	$5,558,976
By-products, not chemical	$3,702,017	$2,209,078
Amount received for custom work	$888,734	

* Includes citric and lactic acids in 1899.

[25] Anhydrous ammonia reported under "Compressed or liquefied gases."

[26] Figures not available for total production of crude glycerine, 1914, as that made and consumed in the manufacture of a large portion of the refined glycerine was not reported.

[27] Produced by chemical plants, 19,206,084 pounds; by rolling mills, 13,158,859 pounds; by wire mills, 60,113,880 pounds.

[28] In addition, 11,690,006 pounds of copperas were made and consumed in the same establishments.

[29] Domestic production of sulphur, United States Geological Survey, 327,634 tons (2,240 pounds); imports for consumption, 26,135 tons.

[30] Comprises: Acetanilid, acetone oil, acid calcium phosphate and calcium salts, aluminum chloride, antimony salts, arsenic (total production, as reported by the Geological Survey, 4,670 tons, valued at $313,147), bismuth salts, cadmium salts, carbon bisulphide, cerium salts and alloys, chrome salts, crown filler, ether (not ethyl oxide), glyco-phosphates, hexamethylene-titramine, iodine resublimed and salts of iodine, iodoform, ketones, lithia and lithium salts, salts of magnesium and manganese, molybdenum, Paris green, sesquisulphite of phosphorus, strontium salts, sulphur chloride, titanium salts, trioxy-methylene and tungsten.

and other fillers are held in solid aggregations which may be molded or shaped. The value of the products reported includes the value of finished goods, such as combs, brushes, other toilet articles, collars and cuffs, buttons, talking-machine records etc. manufactured in the establishments making the plastic material, but does not include that of finished plastic goods made from purchased plastic stock.

The group of compressed or liquified gases (Group 10) embraces all gases which are compressed or liquified for sale, with the exception of illuminating gases (acetylene, Pintsch gas, Blau gas).

The group of fine chemicals (Group 11) embraces chemicals sold in the trade as chemically or absolutely pure; those which are more especially made use of in analytical operations and in pharmacy; and chemicals, like the salts of the precious metals, of a high unit value. The limitations of the group are not sharply defined, and as a result the statistics may not represent the total output of the respective products, since in some cases the data for certain products may have been included with those for unclassified goods, and, as reported at different censuses, may not be strictly comparable.

The figures in Table 108 aim to give the total production of each commodity in so far as the same is ascertainable from the returns, irrespective of whether it is a principal or subsidiary product of the establishment reporting, or the industry under which the establishment is classified. For example, the production of acetic acid, acetone, acetate of lime, and formaldehyde reported in this table includes that made in wood distillation establishments, the figures for which are given in Table 122; and the production of glycerin here reported, both crude and refined, includes the glycerine product of soap works as given in Table 120.

Cleansing and Polishing Preparations

The proucts of the establishments in this industry include washing, ironing, sweeping, and scouring compounds; laundry and floor wax; pumice stone and tripoli; and especially preparations for cleansing and polishing furniture, floors, wall paper, gloves, metal ware, and cars, automobile body polish, paint and varnish removers, rust and stain removers etc. In Table 106 separate statistics are given for those establishments whose products of chief value were cleansing preparations, and for those making polishing preparations as their chief product.

In addition to the products covered by the table, cleaning preparations to the value of $520,846 and polishing preparations to the value of $1,121,178 were reported by establishments assigned to other classifications, principally those making mops, dusters etc. and those making soap.

Some cleansing and polishing preparations may have been reported under "all other products" by the large soap manufacturers and by the few slaughtering and meat-packing establishments where the soap departments were not returned as separate establishments. Washing soda (sal soda) is included under "chemicals."

Coke, Not Including Gas-House Coke

The principal product of establishments under this classification is coke obtained by the distillation of coal in coke ovens. From the "by-product ovens" a number of valuable by-products are obtained—tar, ammonium sulphate, and ammonia liquors. Establishments engaged primarily in the manufacture of gas, and making coke as a subsidiary product, are not included. Statistics of the materials and products for this industry are collected annually by the United States Geological Survey, therefore such data were not reported to the census in 1914. The following table gives the totals for that year as compiled by the United States Geological Survey, in comparison with those for the censuses of 1909, 1904, and 1899.

The total production of coke, including gas-house coke sold and that made and consumed in gas manufacture, was 138,000 tons in 1914 as compared with 41,947,000 in 1909 and 27,857,000 in 1904.

TABLE 120

SOAP

	1914	1909
Number of establishments	513	526
Soap industry	371	420
Manufacturing subsidiary soap products	142	106
Materials[1]		
Total cost	$88,866,786	$72,179,418
Tallow, grease and other fats:		
Pounds	546,289,571	413,969,787
Cost	$32,565,899	$23,341,905
Cocoanut and palm-kernel oil:		
Gallons	13,225,330	11,856,337
Cost	$9,406,583	$5,875,294
Cottonseed oil:		
Consumption, gallons	16,144,786	26,611,810
Purchased—		
Gallons	15,903,691	24,221,712
Cost	$6,700,688	$9,718,988
Produced and consumed, gallons	241,095	2,390,098
Rosin:		
Pounds	185,310,786	207,296,447
Cost	$4,067,992	$4,362,412
Foots:		
Pounds	123,032,886	94,050,892
Cost	$6,456,784	$2,455,609
Caustic soda:		
Tons (2,000 pounds)	55,320	52,172
Cost	$1,936,575	$2,212,232
Soda ash:		
Tons (2,000 pounds)	140,983	121,016
Cost	$1,997,575	$2,281,787
All other materials	$25,734,690	$21,933,191
Produced in works where consumed[1]		
Red oil, gallons	3,653,557	3,128,736
Tallow, pounds	5,331,000	16,664,000
Cottonseed oil, gallons	241,095	2,390,098
Caustic lye (30° Baumé), gallons	22,777,000	15,804,000
Sodium silicate, pounds	43,197,255	37,466,246
Glycerine, pounds	2,156,591	5,879,279
Framed soap, pounds	618,096,000	524,775,000
Products		
Total value	$135,304,499	$115,455,190
Soap industry	$127,942,441	$111,357,777
Subsidiary products, other industries	$7,362,058	$4,097,413
Hard soaps:		
Quantity, pounds	2,064,228,000	1,794,249,000
Tallow soap	938,447,000	944,409,000
Olein soap	42,524,000	33,696,000
Foots soap	111,063,000	73,444,000
Toilet soap	169,926,000	111,571,000
Powdered soap	367,744,000	301,176,000
Soap chips	97,746,000	329,953,000
All other hard soaps	336,778,000	
Value	$104,464,542	$91,064,466
Soft soap:		
Pounds	57,002,000	60,037,000
Value	$1,697,424	$1,269,187
Special soap articles	$832,654	$706,177
Glycerine:[2]		
Crude, for sale—		
Pounds	12,745,336	
Value	$1,817,536	
Refined, pounds	34,831,082	$6,790,282
For sale—		
Pounds	32,674,491	
Value	$5,775,887	
Produced and consumed, pounds	2,156,591	5,879,279
Lye:		
Pounds	23,346,000	
Value	$891,265	
Perfumes and toilet preparations	$6,804,508	$15,625,078
Candles	$150,492	
All other products	[3]$12,870,191	

[1] Not including those consumed in soap manufacture in establishments making subsidiary soap products.

[2] See table 108, chemicals, for total glycerine production.

[3] Includes cottonseed products, $3,008,386; chemicals, $941,379; cleansing and polishing preparations, $500,466; grease and tallow, $235,195; lard oil, $125,706; dyestuffs and extracts, $73,003; patent medicines and compounds, $64,477; and miscellaneous and undesignated products, $7,921,579.

Drug Grinding

Powdered or pulverized drugs are the principal products reported by establishments under this classification, and include the grinding of drugs, charcoal, roots, herbs, gums, licorice roots etc.

TABLE 111

DYESTUFFS AND EXTRACTS

	1914	1909
Number of establishments	133	124
Dyestuff and extract industry	112	107
Establishments manufacturing dyestuffs and extracts as subsidiary products	21	17
Products		
Total value	$21,382,689	$16,788,676
Dyestuff and extract industry	$20,620,336	$15,954,574
Subsidiary products from other industries	$762,353	$834,102
Dyestuffs	$7,114,855	$4,819,247
Natural dyestuffs	$1,862,162	$1,135,694
Dyewood extracts—		
Logwood—		
Number of establishments	9	(1)
Pounds	28,989,962	22,317,248
Value	$1,311,966	$991,974
Fustic—		
Number of establishments	5	(1)
Pounds	4,509,943	(1)
Value	$222,804	(1)
Quercitron—		
Number of establishments	4	(1)
Pounds	3,844,882	(1)
Value	$112,945	(1)
Other dyewood extracts, Brazilwood, cutch, etc.—		
Pounds	3,434,150	(1)
Value	$90,934	(1)
Dyewoods, ground or chipped—logwood, fustic, Brazilwood, turmeric, etc.—		
Pounds	4,128,202	15,046,954
Value	$45,647	$143,720
Dyestuffs, not dyewoods—ground and extracts	$77,866	(1)
Artificial dyestuff:		
Synthetic or coal-tar dyes, including intermediates and products resulting from the blending of imported colors—		
Number of establishments	16	
Pounds	12,169,635	
Value	$4,652,947	
Mineral colors or dyes, such as chrome yellow, orange or green, iron buff, prussian blue, ultramarine, etc.—		12,758,774 $3,683,553
Number of establishments	14	
Pounds	4,991,336	
Value	$599,746	
Tanning materials	$7,898,672	$7,123,971
Extracts—		
Oak—		
Pounds	8,797,218	
Value	$192,844	
Chestnut—		292,400,285
Pounds	319,639,906	$6,132,592
Value	$3,952,806	
Hemlock—		
Pounds	18,978,013	12,588,078
Value	$340,402	$280,487
Sumac—		
Pounds	4,512,361	3,148,790
Value	$129,631	$107,456
Quebracho, chrome tanning, spruce, myrobalans, gambier, mangrove or palmetto, and gallnuts extracts, in the order named as to value—		
Pounds	99,799,418	
Value	$2,944,906	$603,436
Other tanning materials	$338,083	
Mordants:		
Tannic acid—		
Pounds	760,100	
Value	$234,630	$628,798
Other	$157,791	
Assistants:		
Turkey red oil—		
Pounds	11,681,884	1,814,506
Value	$820,491	$108,292
Other	$716,510	(1)
Sizes:		
Dextrins—		
Pounds	18,913,641	
Value	$705,584	16,148,931
Gums, other than rosin—		$610,999
Pounds	3,832,182	
Value	$205,282	
Rosin—		
Pounds	20,717,148	
Value	$373,218	$1,835,046
Other sizes	$1,768,777	
All other products	$1,386,879	$1,662,323

[1] Figures not available.

There are no statistics giving the quantity or value of drugs ground by establishments classed under "patent medicines and compounds," and "druggists' preparations."

Druggists' Preparations, Patent and Proprietary Medicines and Compounds, and Perfumery and Cosmetics

Druggists' Preparations.—This industry includes all materials for use by druggists in compounding medicines to be dispensed upon physicians' prescriptions or orders. These comprise tinctures, fluid extracts, medicinal sirups, and other liquid preparations; pills, tablets, powders etc.; alkaloids and derivatives (cocaine, codein, morphine, quinine, and strychnine); synthetic medicinal preparations, such as acetanilid, acetphenetidin, phenolphthalein, saccharin, methylsalicylate etc.; medicinal metals and their salts (bromides, acetates, citrates, bismuth etc.); and biological products, such as serums, vaccines, toxins etc. Concerns engaged in drug grinding as their principal business are not included in this industry.

Patent medicines and compounds.—This industry consists of "patent and proprietary medicines" which are those sold under the protection of a patent, copyright, or trade-mark, or prepared according to a secret formula; and "patent and proprietary compounds" which include all such compounds not intended for medical use, such as fire-extinguisher compounds, household ammonia, insecticides etc.

Perfumery and cosmetics.—This industry comprises cologne, toilet waters, face powders, cold cream etc. and perfumes.

Dyestuffs and Extracts

Establishments in this industry make materials for dyeing and tanning purposes. The products include natural dyestuffs made from wood, bark, or berries; dyeing extracts; artificial dyestuffs, including synthetic or coal-tar dyes and the mineral colors or dyes; tanning extracts and liquors, including chrome tanning solutions; and mordants, assistants, and sizes. The statistics for dyestuffs and extracts given in the table cover the products of establishments manufacturing the same for sale and do not include those made by dye and print works or tanneries and consumed by the same in further processes of manufacture.

Detail statistics of the quantity and value of the products for the censuses from 1899 to 1914, are given in Table 111.

Explosives

Establishments included in this classification manufacture blasting powder, black gunpowder, nitroglycerin, dynamite, including all explosives containing nitroglycerine, permissible explosives, guncotton, including pyroxylin, and all other cellulose nitrates; smokeless powder; and all other high-powered powders used as propellants. Table 112 gives detail statistics for materials and products, for the census of 1914, in comparison with 1909.

Fertilizers

Establishments included in this classification manufacture principally "complete fertilizers" by which is meant a mixture of superphosphates with both potash

and ammoniates; ammoniated fertilizers; superphosphates from minerals, bones etc.; concentrated phosphates etc. The production, for sale, of sulphuric and other acids, fish scrap, soda products, oil, bone black, glue, grease, and various chemicals is also reported. Large quantities of some of these products are made by fertilizer establishments for their own use.

The quantity and value of the different classes of fertilizers manufactured in 1914 in comparison with those for the censuses of 1909, are given in Table 113. The statistics include the fertilizer products of establishments engaged primarily in the manufacture of products other than fertilizers, chief of which are slaughtering and meat-packing establishments and cottonseed oil mills.

The value of all products of the industry proper, which includes some that are not fertilizers, was $153,196,152 in 1914, as compared with $103,960,213 in 1909. Including the fertilizer by-products of other industries, the total production of fertilizers in 1914 was 8,432,206 net tons, valued at $153,260,212. During the period 1909-1914 the tonnage of the fertilizer products increased 50.1 per cent. Some of the materials, such as sulphuric acid and superphosphates, are the products of establishments engaged in this industry, and therefore are duplicated in the total value of products.

TABLE 112

EXPLOSIVES (TONS OF 2,000 POUNDS)

Materials.	1914	1909
Total cost	$25,626,539	$22,811,548
Sulphur or brimstone:		
Tons	15,832	17,389
Cost	$372,763	$367,866
Pyrites:		
Tons	25,885	[1]
Cost	$139,496	[1]
Nitrate of soda:		
Tons	190,960	188,889
Cost	$8,979,877	$7,892,336
Glycerine:		
Pounds	29,002,008	[1]
Cost	$5,439,405	[1]
Acids:		
Sulphuric—		
Consumption, tons	83,605	65,066
Purchased—		
Tons	52,398	22,501
Cost	$723,795	$406,204
Produced in works where consumed, tons	31,207	42,555
Nitric—		
Consumption, pounds	102,920,184	70,559,756
Purchased—		
Pounds	8,694,684	7,591,756
Cost	$476,404	$541,314
Produced in works where consumed, pounds	94,226,000	62,968,000
Mixed—		
Consumption, pounds	177,306,992	[1]
Purchased—		
Pounds	38,509,594	51,764,694
Cost	$1,047,377	$1,512,626
Produced in works where consumed, pounds	138,797,398	[1]
All other materials	$8,447,422	$12,091,202
Produced in works where consumed		
Acids:		
Sulphuric, tons	31,207	42,555
50° Baume	23,596	[1]
66° Baume	7,611	[1]
Nitric, pounds	94,226,000	62,968,000
Mixed, pounds	138,797,398	[1]
Saltpeter, pounds	5,409,350	12,050,225
Nitroglycerine, pounds	61,517,409	70,289,667
Nitrate of ammonia, pounds	29,891,837	10,904,319
Cellulose nitrates, pounds	3,616,895	5,000,226
Charcoal, bushels	139,508	737,884
Total value	$41,432,970	$40,139,661
Products		
Explosives, total:		
Pounds	[2]481,752,040	[2]487,481,152
Value	$39,645,382	$37,983,868
Dynamite—		
Number of establishments	26	26
Pounds	223,667,630	220,145,791
Value	$20,553,653	$20,998,820
Permissible explosives—		
Number of establishments	20	13
Pounds	18,113,601	9,607,448
Value	$1,604,072	$863,209
Nitroglycerine—		
Number of establishments	58	49
For sale as such	32	23
For consumption	27	26
Production, pounds	65,302,883	74,212,980
Sold as such—		
Pounds	3,785,474	3,923,313
Value	$950,611	$863,360
Consumed in works where produced, pounds	61,517,409	70,289,667
Blasting powder—		
Number of establishments	48	38
Pounds	207,423,675	233,477,175
Value	$8,459,113	$9,608,265
Gunpowder, black—		
Number of establishments	8	8
Pounds	7,685,036	12,862,700
Value	$977,455	$1,736,427
Other explosives—		
Number of establishments—		
Guncotton or pyroxylin	4	2
Smokeless powder	5	4
Other	6	8
Pounds	21,076,624	7,464,725
Value	$7,100,478	$3,913,787
All other products	$1,787,588	$2,155,793

[1] Figures not available.

[2] In addition 5,072,387 pounds, to the value of $1,632,335, were made by Federal establishments, comprising 4,998,537 pounds of smokeless powder and 73,850 pounds of other explosives.

[3] In addition 1,471,042 pounds, to the value of $656,959 were made by Federal establishments and 219,356 pounds to the value of $135,979 by establishments engaged primarily in the manufacture of products other than explosives.

GAS, ILLUMINATING AND HEATING

Establishments under this classification manufacture illuminating and fuel gas, chiefly by destructive distillation of coal, wood, resins, and oil, or other carbonaceous substances. The production of natural gas, of course, is not included. Many manufacturing concerns convert coal, through imperfect combustion, into "producer" gas for use as fuel or in gas engines. This process, however, is not covered by the statistics of the gas industry, nor is the production of blast-furnace gas. The manufacture of Pintsch gas, used principally for lighting railway cars, which carry it in compressed form, is included, likewise Blau gas and acetyline, whether distributed through mains or marketed compressed in cylinders, as well as the operations of municipal gas plants.

The statistics for the industry do not include those for establishments operating retort coke ovens, for which see Table 109. The gas purchased by the gas companies is largely retort coke-oven gas.

TABLE 113

FERTILIZERS (TONS OF 2,000 POUNDS)

	1914	1909
Number of establishments	1,238	843
Fertilizer industry	784	550
Manufacturing fertilizers as subsidiary products	[1]454	293
Materials		
Total cost	$119,222,003	$73,165,544
The fertilizer industry	$107,954,644	$69,521,920
Other industries, fertilizer products	$11,267,359	$3,643,624
Ammoniates:		
Tons	1,213,168	842,557
Cost	$28,550,524	$17,200,611
Cottonseed meal—		
Tons	325,234	
Cost	$8,419,383	
Tankage and ammoniates, not elsewhere specified—		842,557
Tons	887,934	$17,200,611
Cost	$20,131,141	
Ammonium sulphate:		
Tons	149,924	65,592
Cost	$9,015,163	$3,732,112
Cyanamid or lime nitrogen:		
Tons	25,911	[2]
Cost	$1,176,119	[2]
Nitrate of soda:		
Tons	162,184	89,846
Cost	$7,511,809	$3,916,320
For mixed fertilizers—		
Tons	147,050	[2]
Cost	$6,807,228	[2]
For acid manufacture—		
Tons	15,134	[2]
Cost	$704,581	[2]
Phosphate rock:		
Tons	2,080,961	1,549,497
Cost	$11,222,992	$8,828,834
Fish:		
Tons	250,110	242,045
Cost	$3,111,991	$3,066,613
Raw bones:		
Tons	64,590	[2]
Cost	$1,603,353	[2]

TABLE 113—Continued

FERTILIZERS (TONS OF 2,000 POUNDS)

Materials—Continued	1914	1909
Steamed bone:		
Tons	55,067	(1)
Cost	$1,178,959	(1)
Ground bone:		
Tons	25,139	(1)
Cost	$593,226	(1)
Bone discard:		
Tons	3,395	(1)
Cost	$35,007	(1)
Pyrites:		
Tons	613,842	456,574
Cost	$3,590,235	$2,831,994
Sulphur or brimstone:		
Tons	2,041	4,236
Cost	$42,716	$68,924
Sulphuric acid:		
Purchased—		
Tons	728,889	620,708
Cost	$4,387,317	$3,460,132
Made and consumed, tons	1,276,715	841,935
Superphosphate:		
Purchased—		
Tons	1,096,178	532,886
Cost	$9,301,501	$5,175,957
Made and consumed (acid phosphate), tons	2,723,317	1,838,865
Basic slag or Thomas phosphate powder:		
Tons	16,190	(1)
Cost	$144,213	(1)
Guano:		
Tons	120,128	(1)
Cost	$445,416	(1)
Kainit:		
Tons	448,885	347,104
Cost	$3,939,263	$3,008,183
Potash salts:		
Tons	529,973	270,459
Cost	$12,774,113	$7,714,367
Muriate of potash:		
Tons	177,372	(1)
Cost	$6,497,364	(1)
Sulphate of potash:		
Tons	39,232	(1)
Cost	$1,684,998	(1)
Double manure salts:		
Tons	108,580	(1)
Cost	$1,740,241	(1)
Nitrateof potsh or saltpeter—		
Tons	507	(1)
Cost	$28,287	(1)
Other potash salts—		
Tons	[2]204,282	(1)
Cost	$2,823,223	(1)
Hardwood ashes:		
Tons	4,437	(1)
Cost	$54,171	(1)
All other materials	$20,543,915	$14,161,497
Products		
Total value	$169,017,550	$111,871,481
Fertilizer industry	$153,196,152	$103,960,213
Subsidiary fertilizer products, other industries	$15,821,398	$7,911,268
Fertilizers:		
Tons	8,432,206	5,618,234
Value	$153,260,212	$100,089,971
Complete and ammoniated fertilizers[4]—		
Tons	5,612,421	3,523,759
Value	$121,676,386	$74,109,307
Superphosphates—		
Production, tons	4,416,022	3,062,834
For sale (tons)	1,692,705	1,223,969
For sale (value)	$14,778,654	$13,744,831
Made and consumed, tons	2,723,317	1,838,865
Concentrated phosphate—		
Tons	67,585	270,128
Value	$1,367,005	$2,713,513
Other fertilizers—		
Tons	1,059,495	600,378
Value	$15,438,167	$9,522,320
Sulphuric acid (reduced to 50° Baume):		
Production, tons	1,405,768	995,384
For sale (tons)	129,053	153,449
For sale (value)	$768,873	$928,582
Made and consumed, tons	1,276,715	841,935
Fish scrap:		
Tons	62,930	78,484
Value	$1,915,530	$2,006,724
Pyrite cinder:		
Tons	[2]245,082	[2]291,653
Value	$231,869	$143,607
Oil:		
Gallons	2,445,026	3,218,393
Value	$778,337	$810,938
Bone black:		
Pounds	41,054,769	(1)
Value	$1,413,166	(1)
Glue	$1,131,243	(1)
Grease	$1,209,334	(1)
All other products	[6]$8,308,986	$7,891,659

[1] Includes 179 cottonseed-oil mills, 64 grease and tallow establishments, 45 slaughtering and meat packing, and 166 distributed among some 15 other industries that produce wastes of fertilizing value.
[2] Figures not available.
[3] Includes 17,430 tons reported simply as potash salts.
[4] Includes fertilizers reported as ammoniated fertilizers but containing both superphosphates and potash, viz., in 1914, 1,519,156 tons; 1909, 522,389 tons; 1904, 775,987 tons; and 1899, 142,898 tons.
[5] Not including 155,634 tons in 1914, and 72,402 tons in 1909, of no value at the works.
[6] Includes chemicals—soda products, acids, etc—to the value of $400,597.

The total production of gas made for sale by all establishments, inclusive of retort coke-ovens and the by-products of establishments outside of the gas and the coke industries, was, in 1914, 265,060,574 thousand cubic feet, valued at $181,207,482, and in 1909, 166,667,641 thousand cubic feet, valued at $141,478,557.

TABLE 109

COKE (TONS OF 2,000 POUNDS)

Coal	1914[1]	1909[1]
Coal charged into ovens:		
Tons	51,623,750	59,354,937
Cost	$74,949,565	$62,203,382
Run of mine, tons—		
Unwashed	36,517,276	40,594,842
Washed	5,515,290	6,067,760
Slack, tons—		
Unwashed	4,289,870	6,926,484
Washed	5,301,314	5,825,851
Products		
Total value	$105,863,305	$98,078,383
Coke:[2]		
Tons	34,555,914	39,315,065
Value	$88,334,217	$89,965,483
Made in beehive ovens—		
Tons	23,335,971	33,060,421
Value	$50,254,050	$69,530,794
Made in retort or by-product ovens—		
Tons	11,219,943	6,254,644
Value	$38,080,167	$20,434,689
By-products obtained from retort or by-product ovens:		
Gas—		
Cubic feet (thousands)	61,364,375	15,791,220
Value	$6,009,583	$2,609,211
Tar—		
Gallons	109,901,315	60,126,006
Value	$2,867,274	$1,408,611
Ammonia, sulphate or reduced to equivalent in sulphate—		
Pounds	170,763,906	123,111,197
Value	$4,696,590	$3,227,316
Anhydrous ammonia—		
Pounds	[3]25,370,509	4,871,014
Value	$2,300,137	$448,455
Ammonia liquor—		
Gallons	5,938,233	(4)
Value	$658,497	(4)
All other, value	[5]$997,007	$419,307
Equipment		
Ovens, number in existence at end of year	99,755	103,982
Building at end of year	1,249	2,950
Abandoned during the year	3,675	201

[1] Includes coal and coking products produced by establishments engaged primarily in the manufacture of products other than those covered by the industry designation.
[2] Not including gas-house coke, the statistics for which will be found under the classification "Gas, illuminating and heating."
[3] Mainly ammoniacal liquor sold on pound basis of NH_3.
[4] Reported in part as anhydrous ammonia and in part as ammonium sulphate or reduced equivalents.
[5] Mainly benzol.

The statistics for materials and products for 1914, in comparison with those for 1909, are given in Table 114.

Glue Not Elsewhere Specified

The principal products of establishments included in this classification are glue, flexible and liquid; gelatin; and glue jelly or paste, derived from hides, bones, fleshings, and fish.

In addition to the products covered by Table 106 glue and gelatin to the value of $3,088,764 were made in slaughtering and meat-packing establishments, while fertilizer factories reported glue to the value of $1,131,243. Other establishments, principally those making sand and emery paper and cloth, tallow, soap stock, food preparations, oleo oil and fish oil, reported glue and gelatine to the value of $1,772,872, making the total manufacture of glue $19,725,703 in 1914, as compared with $16,328,579 in 1909.

Grease and Tallow, Not Including Lubricating Greases

Establishments in this classification render soap grease from fat, bones, meat, scraps, garbage etc., and render tallow from the solid fat of cattle, sheep, and

other animals. Establishments making grease and tallow reported hides, skins, bones, tankage, fertilizers, poultry feed, dried blood, oils, stearine, cracklings, hoofs, horns, glue stock, ground bones etc.

Table 106 gives separate statistics for those establishments making soap stock, for those rendering tallow, and for those reporting other products, respectively, classified according to the product of chief value.

There is considerable overlapping between the three subclassifications, as soap stock to the value of $598,876 was made by those establishments rendering tallow and other products, while tallow to the value of $265,491 was reported by those making soap stock, and other products to the value of $23,858 were made by tallow plants. In addition, soap stock to the value of $1,209,334 was reported by the fertilizer industry, and to the value of $3,742,747 by slaughtering and meat-packing establishments, while establishments assigned to other classifications, principally glue, reported soap stock to the value of $1,311,839.

Tallow to the value of $12,371,206 was reported by slaughtering and meat-packing establishments, and to the value of $744,143 by establishments assigned to other classifications, principally oleo oil. These amounts are in addition to the products shown in the tables.

Lubricating Greases

This classification includes establishments engaged primarily in the manufacture of grease lubricating compounds and axle grease for automobiles, carriages, wagons, and railway cars. The industry was known as "axle grease" prior to 1914, and was first reported separately at the census of 1879.

In addition to the products covered by Table 106 petroleum refineries reported the production of lubricating and axle greases to the value of $2,293,103, in

TABLE 114

GAS, ILLUMINATING AND HEATING

	1914	1909
Number of establishments	1,284	1,296
Commercial	1,146	1,177
Municipal	138	119
Number manufacturing—		
Straight coal gas	277	343
Carbureted water gas	430	325
Mixed coal and water gas	147	154
Oil gas	[a] 153	179
Acetylene	[b] 165	158
All other gas (gasoline, cold process)	112	137
Number operating gas and electric light and power plants in conjunction	[c] 385	[c]389
Total cost	$76,779,288	$52,427,844
Coal used for gas making:		
Tons (2,000 pounds)	6,116,672	4,940,598
Cost	$20,872,517	$16,304,832
Oil used for gas making:		
Gallons	715,418,623	578,309,411
Cost	$24,720,998	$17,105,981
Benzene or benzol:		
Purchased—		
Gallons	388,146	253,837
Cost	$54,653	$27,543
Made and consumed, gallons	99,238	302,994
Bensine, gasoline, or naphtha:		
Gallons	998,353	1,093,874
Cost	$169,020	$212,226
Coke used for gas making:		
Tons (2,000 pounds)	964,851	591,919
Cost	$4,500,289	$2,667,706
Calcium carbide:		
Pounds	31,749,491	6,080,465
Cost	$887,937	$195,836
Gas purchased:		
Cubic feet, thousands	28,351,074	16,769,705
Cost	$8,883,016	$5,416,601
Fuel for boilers and retorts	$3,784,911	$2,369,131
Amount paid for lamps and appliances purchased for sale	$7,393,224	$5,537,936
All other materials	$5,512,723	$2,590,052
Products		
Total value	[d]$220,237,790	[d]$166,814,371
Gas:		
For sale—		
Cubic feet, thousands	203,639,260	150,835,793
Value	$175,065,920	$138,615,309
Average value 1,000 cubic feet	$0.86	$0.92
Made and consumed, 1,000 cubic feet	1,121,108	1,730,563
Straight coal—		
Cubic feet, thousands	10,509,946	19,985,253
Value	$10,726,514	$18,065,841
Average value 1,000 cubic feet	$1.02	$0.90
Carbureted water—		
Cubic feet, thousands	90,017,725	81,144,568
Value	$74,516,534	$70,802,780
Average value 1,000 cubic feet	$0.83	$0.87
Mixed coal and water—		
Cubic feet, thousands	86,281,339	40,775,283
Value	$72,012,021	$36,953,543
Average value 1,000 cubic feet	$0.83	$0.91
Oil—		
Cubic feet, thousands	16,512,274	8,688,860
Value	$15,044,509	$12,111,458
Average value 1,000 cubic feet	$0.91	$1.39
Acetylene—		
Distributed through mains—		
Cubic feet, thousands	14,868	
Value	$194,019	
Average value 1,000 cubic feet	$13.05	25,186
Delivered in containers (compressed)—		$361,348
Cubic feet, thousands	121,696	$14.35
Value	$2,317,605	
Average value 1,000 cubic feet	$19.04	
All other gas (gasoline, cold process)—		
Cubic feet, thousands	181,412	216,643
Value	$254,718	$320,339
Average value 1,000 cubic feet	$1.40	$1.48

Products—Continued.	1914	1909
Coke:		
Production, bushels	179,128,257	131,599,836
For sale—		
Bushels	114,091,753	82,049,683
Value	$8,719,920	$5,723,215
Made and consumed, bushels	65,036,504	49,550,153
Tar:		
Production, gallons	153,311,196	109,930,058
For sale—		
Gallons	125,938,607	78,339,880
Value	$3,252,765	$1,875,549
Made and consumed, gallons	27,372,589	31,590,178
Ammonia liquors (16-ounce strength):		
Gallons	50,737,762	37,277,864
Value	$1,235,442	$725,702
Ammonium sulphate:		
Pounds	6,216,618	[1]
Value	$134,196	[1]
Hydrocarbons	$35,902	$44,509
All other products	$20,815,871	$12,786,697
Receipts from rents and sales of lamps and appliances	$10,977,774	$7,043,390
Candlepower—average for the year:		
Number of establishments reporting candlepower—		
15 and less	50	34
16 and 17	290	228
18, 19, and 20	431	405
21, 22, and 23	153	179
24 and over	[f]131	291
Number not reporting candlepower	229	159
British thermal units—per cubic foot:		
Number of establishments reporting B. t. units—		
Less than 500	3	
500 to 599	163	
600 to 699	577	
700 to 899	11	[1]
900 to 1,300	[g]45	
Over 1,300	[g]11	
Number not reporting B. t. units	474	
Miles of mains	58,727	45,119
Gas stoves and heaters, number connected with mains at end of year[e]	5,168,924	3,603,435

[1] Figures not available.

[2] Includes 61 Pintsch gas and 4 Blau gas.

[3] Includes 40 without distributing mains; gas sold compressed in cylinders.

[4] Number operated under same company name: 1914, 377; 1909, 372.

[5] Includes amount paid for lamps and appliances, $4,013,885, not included in Table 223.

[6] In addition the following products of gas manufacture were produced commercially by 6 establishments in 1914 and 4 in 1909, engaged primarily in other lines of manufacture:

	1914	1909
Products, total value	$158,743	$261,802
Gas:		
Cubic feet, thousands	56,939	40,628
Straight coal	41,744	27,558
Carbureted water	10,154	
Acetylene (compressed)	5,041	13,070
Value	$131,979	$254,037
Coke:		
Bushels	114,371	44,347
Value	$9,356	$3,399
Tar:		
Gallons	35,100	38,370
Value	$2,076	$1,372
Receipts from rents and sales of lamps and appliances	$15,332	$2,994

[7] Includes 47 Pintsch gas, 18 acetylene, and 28 gasoline gas.

[8] Chiefly Pintsch gas, acetylene, and Blau gas.

[9] Includes only those of which the company has record.

1914, and establishments assigned to other classifications, principally those making fish and miscellaneous oils, reported lubricating grease to the value of $1,755,586.

Ink, Printing

The mixing of boiled oil or varnish with black or other pigments to be used in printing is the principal business of establishments in this classification, which includes printing, lithographing, and embossing inks, colored inks, and gold and bronze ink. At the censuses of 1849 and 1879 there was no separate presentation of the statistics, the classification "ink" including both printing and writing ink.

In addition to the products covered by Table 106 printing inks to the value of $177,672 in 1914 and of 89,839 in 1909 were reported by establishments assigned to other industries, principally "bags, other than paper," "paints," and "stationary goods, not elsewhere specified."

Ink, Writing

Establishments under this classification manufacture inks consisting principally of an infusion of galls, copperas, gum arabic, and pigments of various kinds. At the censuses of 1849 and 1879 only the totals for "ink" of all kinds were given. Establishments making writing inks also reported the manufacture of mucilage and paste in 1914 to the value of $616,926. This is included in the value of products shown in the table.

In addition to the value given in Table 106 writing ink to the value of $67,508, in 1914, and of $59,965, in 1909, was reported by establishments assigned to other classifications, principally those making glue, typewriter ribbons, mucilage, and polishing preparations.

Oil, Cottonseed and Cake

The establishments under this classification are engaged primarily in the manufacture of oil, cake and meal, hulls, and linters from cotton seed, and in some cases in the refining of oil. Table 115 presents the statistics for cottonseed products for the last four censuses.

TABLE 115.

COTTONSEED PRODUCTS (TONS OF 2,000 POUNDS)

	1914	1909
Cotton seed, crushed, tons	4,790,774	3,798,549
Products, total value	$212,127,024	$147,867,894
Primary products manufactured, whether for sale or for further use:		
Crude oil, gallons	191,163,261	157,115,689
Cake and meal, tons	2,191,610	1,661,734
Hulls, tons	1,385,940	1,258,612
Linters, pounds	330,624,502	174,620,099

In addition, cottonseed products to the value of $2,638,390 in 1914 and of $2,017,305 in 1909 were reported by establishments assigned to other industries. These establishments crushed, in 1914, 56,854 tons of seed and produced 2,169,758 gallons of crude oil, 25,768 tons of cake and meal, 16,969 tons of hulls, and 3,492,011 pounds of linters. In 1909 they crushed 28,752 tons of seed, and produced 1,212,852 gallons of crude oil, 12,811 tons of cake and meal, 8926 tons of hulls, and 1,152,978 pounds of linters.

Oil, Essential

Establishments under this classification extract or distil the oils of various plants, such as peppermint, spearmint, wormwood, pennyroyal, wintergreen, fleabane, tansy, and fireweed. Black birch, spruce, cedar, juniper and sassafras oils, peppermint-camphor (menthol) and witch-hazel extract are among the products.

The decrease in the value of products for the decade 1869-1879 may be accounted for on the supposition that in 1869 the production on farms was included in the manufacturers' statistics, and that in 1879 it was given with statistics of agriculture. The depreciated currency of 1869 also increased the nominal value of the products that year by about one-fifth.

The quantity and value of the natural oils, and of witch-hazel extract produced, and the value of all other products of the essential-oil industry for 1914 and 1909 are shown in Table 116.

TABLE 116

ESSENTIAL OILS

	1914[1]	1909[1]
Number of establishments	107	74
Products		
Total value	$2,565,361	$1,773,304
Essential oil, value	$1,289,482	$1,111,805
Peppermint—		
Pounds	363,991	305,781
Value	$601,617	$519,079
Spearmint—		
Pounds	94,209	33,400
Value	$238,074	$83,283
Black birch—		
Pounds	41,178	67,053
Value	$67,691	$102,045
Wintergreen—		
Pounds	6,000	22,281
Value	$24,538	$68,983
Wormwood—		
Pounds	4,702	
Value	$9,040	$338,415
Other essential oils	$348,522	
Witch-hazel extracts:		
Gallons	917,690	691,823
Value	$575,938	$419,793
All other products	$699,941	$241,706

[1] Includes two establishments in 1914 and six in 1909 which were engaged primarily in other industries.

Oil, Linseed

The expressing of oil from flaxseed is the chief business of the establishments in this classification, but oil cake and meal and ground flaxseed were also among the products. Linseed oil is used principally in mixing paints. In addition to the products covered by Table 106 raw linseed oil to the value of $1,201,839 in 1914 and to the value of $1,106,181 in 1909 was made for sale in paint and varnish factories, and to the value of $84,408 in 1914 and of $63,100 in 1909, by establishments assigned to other industries.

Oil, Not Elsewhere Specified

The compounding and blending of mineral, animal, and vegetable oils for lubricating purposes and the manufacture of castor oil, oleo oil, fish or whale oil, resinol and neat's-foot oil, floor oil, signal oil, coconut oil, wool oil, palm oil, and lard oil etc. constitute the operation carried on by the establishments in this classification.

Table 106 gives separate figures for the establishments whose products of chief value were "fish oil," "oleo oil," and "all other" oils. In addition to the products covered by the table, oil to the value of $778,337, chiefly "fish oil," was reported by manufacturers of fertilizers, and "fish oil" to the value of $164,373 by establishments assigned to other classifications, principally those making miscellaneous oils and grease and tallow.

Oleo oil was reported by slaughtering and meat-packing establishments to the value of $11,925,852 and

by grease and tallow factories to the value of $471,771. In 1909, slaughtering and meat-packing establishments reported oleo oil to the value of $16,475,726, and miscellaneous oils to the value of $6,350,745, while fertilizers reported oils to the value of $810,938, and establishments assigned to other classifications reported oils to the value of $2,651,710.

Miscellaneous oils to the value of $4,009,602 were reported by slaughtering and meat-packing establishments and to the value of $3,400,175 by establishments assigned to other classifications, principally those making fish oil, paints, chemicals, food preparations, soap stock, and starch.

Paint and Varnish

Paints.—The principal products of establishments in this industry are pigments, and the mixtures of these with linseed oil, turpentine, benzine, wood alcohol etc. which constitute paint in paste or ready for use. Water paints and kalsomine, stains, and putty are also among the products. The manufacture of white lead or of zinc white is the sole or principal business of some concerns, while some are engaged solely in paint mixing, using the materials made by other establishments. There is thus considerable duplication in the gross value of products for the industry as a whole. Many manufacturing and other concerns mix paints for their own use, the value of which is not reported; but the materials used for such paints are mainly covered by the data for the paint and varnish, linseed oil and turpentine and rosin industries.

Varnishes.—The establishments in the varnish industry manufacture principally varnishes consisting of solutions of gums of various kinds, or of rosins, in solvents such as alcohol, linseed oil, turpentine, naphtha and benzine. Among the products are the black varnishes called japans, enamels, and fillers made of linseed oil with powdered glass, ground slate, or silica. In some instances in both paint and varnish establishments other products are reported as made for sale, such as linseed

TABLE 117

PAINT AND VARNISH

	1914	1909
Number of establishments	856	863
Paint industry	585	588
Varnish industry	215	203
Establishments manufacturing paint or varnish as subsidiary products	56	72
Certain specified materials used:		
Pig lead—		
Tons (2,000 pounds)	150,762	150,163
Cost	$11,488,113	$12,380,524
Grain alcohol—		
Gallons	1,061,324	356,225
Cost	$436,509	$226,724
Wood alcohol—		
Gallons	987,451	1,325,807
Cost	$422,122	$693,362
Linseed oil—		
Gallons	24,481,623	[1]
Cost	$12,049,218	[1]
Gums—		
Pounds	48,902,000	[1]
Cost	$4,797,944	[1]
Products		
Total value	$149,130,873	$127,472,819
Paint industry	$112,408,742	$94,572,005
Varnish industry	$33,214,949	$30,317,417
Subsidiary products from other industries	$3,507,182	$2,583,397
Colors (pigments)[2]	$17,407,955	$18,134,869
White lead—		
Production, pounds	279,269,860	247,971,503
For sale—		
Pounds	71,643,812	85,269,414
Value	$3,697,702	$3,924,528
Made and consumed, pounds	207,626,048	162,702,089
Lead oxides—		
Production, pounds	61,335,290	70,293,679
For sale—		
Pounds	58,642,588	65,767,254
Value	$3,281,716	$3,798,551
Made and consumed, pounds	2,692,702	4,526,425
Barytes—		
Pounds	46,920,380	56,254,838
Value	$325,922	$348,470
Iron buff and other earth colors—		
Pounds	92,896,956	213,285,734
Value	$797,819	$1,085,438
Lithopone—		
Pounds	48,972,062	
Value	$1,857,510	
Chrome yellow—		
Pounds	5,747,317	
Value	$641,534	
Orange or green—		
Pounds	8,024,409	
Value	$677,329	163,713,582
Prussian blue—		$6,523,728
Pounds	1,239,382	
Value	$387,077	
Ultramarine—		
Pounds	2,698,639	
Value	$222,769	
Other dry colors—[3]		
Pounds	95,616,993	
Value	$3,616,445	
Vermilion (true)—		
Pounds	322,759	259,558
Value	$200,134	$107,472
Fine colors not elsewhere specified—		
Pounds	4,215,874	8,420,120
Value	$690,235	$1,052,443
Pulp colors, sold moist—		
Pounds	21,420,854	28,600,222
Value	$1,011,763	$1,294,239

Products—Continued.	1914	1909
Paints	$70,582,461	$57,380,539
In paste form, ground in oil—		
White lead—		
Pounds	281,417,563	246,569,970
Value	$18,141,444	$15,234,539
Zinc—		
Pounds	9,551,840	
Value	$730,918	
All other—		165,038,353
Pounds	129,042,658	$11,435,937
Value	$10,165,819	
In oil, already mixed for use—		
Gallons	40,745,563	34,278,989
Value	$41,544,280	$30,710,063
Varnishes and japans	$36,142,256	$31,758,735
Oleoresinous varnishes—		
Gallons	17,801,438	18,692,527
Value	$18,762,399	$17,559,898
Spirit varnishes, not turpentine—		
Gallons	2,964,172	1,273,411
Value	$3,080,425	$1,502,398
Damar and similar turpentine and benzine varnishes—		
Gallons	3,297,371	3,483,994
Value	$2,865,256	$2,839,534
Pyroxylin varnishes—		
Gallons	852,571	1,886,541
Value	$1,308,796	$2,356,692
Drying japans and dryers—		
Gallons	6,560,406	6,638,706
Value	$3,015,907	$3,165,589
Baking japans and lacquers—		
Gallons	4,888,816	2,983,285
Value	$2,960,856	$2,079,927
All other	$4,148,617	$2,254,697
Fillers—		
Liquid—		
Gallons	965,636	1,166,533
Value	$670,033	$828,393
Dry or in paste—		
Pounds	49,587,548	65,148,395
Value	$1,318,720	$1,199,595
Putty—		
Pounds	69,828,017	67,767,348
Value	$1,250,421	$1,169,683
Water paints and kalsomine—		
Dry or in paste—		
Pounds	61,904,258	47,465,715
Value	$2,055,180	$1,917,047
Mixed for use—		
Gallons	297,173	543,733
Value	$147,101	$64,114
Linseed oil—		
Raw—		
Gallons	2,230,988	2,098,696
Value	$1,201,839	$1,106,181
Boiled—		
Gallons	572,561	1,379,025
Value	$306,569	$806,846
Other oils	$999,392	[1]
Bleached shellac—		
Pounds	8,654,514	3,905,593
Value	$1,806,802	$772,240
Acetate of lead—		
Pounds	2,896,313	[1]
Value	$150,587	[1]
Driers—		
Gallons	1,047,140	[1]
Value	$257,725	[1]
All other products	$14,833,832	$12,334,577

[1] Figures not available.

[2] In addition, in 1914, 106,791 tons of pigments, valued at $9,978,710, were made by smelters direct from the ore, and 66,766 tons of natural mineral pigments, valued at $473,076, were marketed; and in 1909, 87,525 tons of pigments, valued at $7,963,332, were made by smelters direct from the ore, and 61,137 tons of natural mineral pigments, valued at $613,133, were marketed.

[3] Includes lampblack and other carbon blacks made by paint and varnish establishments. See Table 107 for bone, carbon, and lampblack statistics.

oil, raw and boiled, and bleached shellac, but larger quantities of such products are made for use in the same establishment.

The inquiry at the present census in regard to specific materials used in the manufacture of paints and varnishes was confined to pig lead, alcohol (grain and wood), linseed oil, and gums. The statistics for paint and varnish products and the consumption of the above-named materials are given in Table 117 for 1914 and 1909.

PETROLEUM, REFINING

All crude petroleum refineries are included under this classification. The principal products are illuminating fuel, and lubricating oils, gasoline, and paraffin wax. Other products are lubricating and other greases, oil asphaltum, coke, black naphtha, tar, and sludge acid and residuums.

The products of the petroleum-refining industry, statistics for which are presented in Table 118, aggregated $396,361,406 in value in 1914, as compared with $236,-

TABLE 118

PETROLEUM, REFINING

	1914	1909
Number of establishments	176	147
Materials		
Total cost	$325,264,509	$199,273,402
Crude petroleum used[1]		
Barrels (42 gallons)	191,262,724	120,775,439
Cost	$249,727,856	$152,307,040
California—		
Barrels	41,901,651	13,481,885
Cost	$30,157,013	$10,108,541
Mid-Continent—		
Barrels	92,462,637	42,895,051
Cost	$121,188,441	$41,959,100
Pennsylvania grade—		
Barrels	21,196,964	24,508,218
Cost	$50,019,939	$47,545,138
Illinois—		
Barrels	17,672,279	26,236,883
Cost	$30,137,986	$36,218,407
Gulf—		
Barrels	5,787,313	5,262,664
Cost	$6,080,907	$4,669,486
Lima-Indiana—		
Barrels	2,564,742	8,083,096
Cost	$4,286,588	$11,455,764
Colorado and Wyoming—		
Barrels	3,441,893	307,642
Cost	$2,088,700	$350,604
Mexican—		
Barrels	6,235,245	[2]
Cost	$5,768,282	[2]
Partly refined oils and waxes purchased:		
Barrels (50 gallons)	7,942,444	[2]
Cost	$24,395,541	[2]
Caustic soda:		
Tons	11,108	
Cost	$361,421	
Sulphur and pyrites	[3]$206,053	
Sulphuric acid:		
Consumption, tons (2,000 pounds)	328,895	$4,003,198
Purchased—		
Tons	290,455	
Cost	$3,519,552	
Made and consumed, tons	38,440	48,580
Containers and materials therefor:		
Wooden	$12,944,471	$8,937,421
Metal	$7,292,207	$8,037,467
Fuel and rent of power	$13,567,284	$8,376,383
All other materials	$13,250,124	$17,611,893
Products		
Total value	$396,361,406	$236,997,659
Naphthas and lighter products:		
Gasoline (petroleum refineries)—		
Barrels (30 gallons)	[4]23,908,242	
Value	$106,140,170	
All other:		10,806,550
Barrels	5,292,522	$39,771,959
Value	$15,779,137	
Illuminating oils:		
Barrels	38,705,496	33,495,798
Value	$96,806,452	$94,547,010
Fuel oils:		
Barrels	74,681,841	34,034,577
Value	$84,017,916	$36,462,883
Distillates—		
Barrels	9,149,833	[2]
Value	$15,999,342	[2]
Gas oils—		
Barrels	15,111,168	[2]
Value	$22,805,340	[2]
Residual fuel oils—		
Barrels	50,420,840	[2]
Value	$45,213,234	[2]
Lubricating oils:		
Barrels	10,356,776	10,745,885
Value	$55,812,120	$38,884,236
Pale or paraffin; viscosity less than 100 per cent Universal; or flash under 400 per cent Fahrenheit, closed cup—		
Barrels	1,868,442	3,239,230
Value	$8,084,650	$9,473,975
Red or neutral; viscosity 100 per cent Universal; or flash 400 per cent Fahrenheit, or over, closed cup (not including cylinder oils)—		
Barrels	2,327,050	614,884
Value	$12,426,023	$2,255,924
Cylinder oils—		
Barrels	2,058,982	1,587,579
Value	$13,703,772	$9,482,568
All other lubricating oils, including compounded (except cylinder) oils—		
Barrels	4,102,302	[7]5,304,192
Value	$21,597,675	$17,671,769
Residium or tar, including liquid asphaltic road oils:		
Barrels	2,696,887	1,787,008
Value	$4,017,858	$2,215,623
Greases:		
Barrels	280,128	138,302
Value	$3,536,491	$1,567,647
Petrolatum, mineral jelly, etc.—		
Barrels	121,561	[2]
Value	$1,243,388	[2]
Lubricating greases—		
Barrels	99,603	[2]
Value	$1,624,949	[2]
Axle grease—		
Barrels	58,964	[2]
Value	$668,154	[2]
Paraffin wax:		
Barrels	1,150,776	946,830
Value	$8,897,106	$9,388,812
Asphalt, other than liquid asphalt:		
Tons (2,000 pounds)	465,157	233,328
Value	$4,867,213	$2,724,752
Coke:		
Tons	213,777	[2]
Value	$818,889	$507,695
Reclaimed or separated acid sold (calculated at 66° Baumé):		
Tons	89,792	133,215
Value	$491,380	$402,295
Candles	$1,402,945	$10,524,747
Other special products	[8]$8,507,993	
All other products	$5,265,736	
Equipment		
Stills, number	3,639	2,395
Steam—		
Number	612	467
Capacity (barrels, 42 gallons)	426,000	431,000
Fire—		
Number	3,027	1,928
Capacity	2,021,000	1,657,000
Agitators	770	529
Chilling houses for paraffin	76	79
Hydraulic or other presses	459	357
Storage tanks for—		
Crude petroleum—		
Number	1,014	678
Capacity (gallons)	580,202,000	242,591,000
Refined petroleum products—		
Number	6,967	6,476
Capacity	1,042,836,000	1,041,627,000
Fuel oil—		
Number	807	.....
Capacity	343,132,000	.....
Other storage tanks—		
Number	4,111	[2]
Capacity	646,608,000	[2]

[1] Crude petroleum production (United States Geological Survey) and refinery consumption, by fields:

Field	1914 Production (United States)	1914 Consumption by Refineries	1909 Production (United States)	1909 Consumption by Refineries
Total number of barrels (42 gallons)	265,762,535	191,262,724	183,170,874	120,775,439
California	99,775,327	41,901,651	55,471,601	13,481,885
Mid-continent (Kansas Oklahoma, etc.)	97,995,400	92,462,637	50,833,740	42,895,051
Pennsylvania grade (Appalachian)	24,101,048	21,196,964	26,535,844	24,508,218
Illinois	21,919,749	17,672,279	30,898,339	26,236,883
Gulf	13,117,528	5,787,313	10,883,240	5,262,664
Lima, Indiana	5,062,543	2,564,742	8,211,443	8,083,096
Colorado, Wyoming, and other fields (United States)	3,790,940	3,441,893	336,667	307,642
Mexican	.....	6,235,245	.....	.....

[2] Figures not available. [3] Included under "All other materials."
[4] Quantities represented, sulphur 2,035 tons, pyrites 23,669 tons.
[5] Includes "wet" natural gas estimated at 1,500,208 thousand cubic feet, cost $92,476, used by refineries.
[6] The production of casing-head gasoline—that made at the wells from natural gas—was 853,053 barrels (42,652,632 gallons). Excluding duplication on account of casing-head gasoline reported by refineries the total production of gasoline was 24,711,565 barrels (50 gallons).
[7] Includes 2,564,812 barrels reported as reduced oil.
[8] Includes partly finished stock, paraffin acid oil, tree sprays, etc.

997,659 in 1909, the increase during the last decade (1904-1914) being 126.5 per cent. This conforms closely to the increase in the cost of crude petroleum used, which was 132.3 per cent. The crude petroleum used increased in quantity from 66,982,862 barrels of 42 gallons in 1904 to 191,262,724 barrels in 1914, or 185.5 per cent, and the refined-oil products aggregated 40,290,985 barrels of 50 gallons in 1899, 46,454,062 barrels in 1904, 89,082,810 barrels in 1909, and 152,944,877 barrels in 1914, an increase for the last decade of 229.2 per cent.

Salt

All establishments producing salt, whether by mining or by evaporation, as well as those refining salt, are included in this classification. The products include brine, bromine, and calcium chloride. The major part of the business is of the nature of manufacturing rather than of mining or extracting material from the earth.

Statistics of the materials and products for this industry are collected annually by the United States Geological Survey, therefore such data were not reported to the census in 1914. Table 119 gives the totals for that year as compiled by the United States Geological Survey in comparison with those for the census of 1909.

TABLE 119

SALT

Product	1914	1909
Total value	$14,070,333	$11,327,834
Salt:		
Barrels	[1]34,804,683	29,933,060
Value	$10,271,358	$8,311,729
Bromine:		
Pounds	576,991	569,725
Value	$203,094	$57,600
Calcium chloride:[2]		
Tons (2,000 pounds)	19,403	12,853
Value	$121,766	$63,198
All other products, value	$3,474,115	$2,895,307
Salt, classified by grade (barrels):		
Table and dairy	4,121,574	3,042,824
Common fine	6,237,860	7,745,204
Common coarse	3,789,163	2,843,393
Packers		385,802
Coarse solar	1,080,199	1,109,396
Rock salt, mined	7,577,172	5,938,721
Milling, other grades, and brine	11,998,715	8,867,720

[1] Includes solar salt of Porto Rico.
[2] From natural brine; not including that obtained in connection with the manufacture of soda.

Soap

Establishments under this classification manufacture chiefly hard soaps, including powdered soaps, toilet, shaving and special soaps; soft soaps, and glycerine.

The statistics for the soap industry, given in Table 120 for 1914 and 1909 include those for the soap factories operated by the owners of slaughtering and meat-packing establishments, as well as for establishments engaged primarily in the manufacture of soap. In 1899 the manufacture of soap and of candles was reported as one industry, the value of products being $53,231,017. In 1904 the value of the combined products of these industries was $72,164,062, in 1909, $114,488,298, and in 1914, $129,673,164.

The cost of the materials used in the soap industry was $88,866,786 in 1914, $72,179,418 in 1909, and $43,625,608 in 1904, the increase for the ten-year period being 103.7 per cent. The value of all products was $127,942,441 in 1914, $111,357,777 in 1909, and $68,274,700 in 1904, the increase for the ten-year period being 87.4 per cent. With the addition of the by-products from establishments in other industries the total value of soap products was $135,304,499 in 1914. The chief soap product was hard soap, which, including that made in establishments engaged primarily in the manufacture of products other than soap, aggregated 1,032,114 net tons in 1914. Glycerine is an important product of the soap industry. Reference should be made to Table 108 for the total glycerin product, including that of chemical establishments.

Turpentine and Rosin

The establishments included in this classification distil the gum exuded from the southern pine, the distillate being turpentine and residuum rosin. Establishments engaged in the destructive distillation of wood are not included here, but under "wood distillation." The industry includes the extraction of the raw material from the trees as well as its distillation. The decrease shown in value of products during the decade 1859-1869 was due primarily to the Civil War.

Table 121 gives the quantity and value of the turpentine and rosin produced in 1914 and 1909.

TABLE 121

TURPENTINE AND ROSIN

Product	1914	1909
Total value	[1]$20,990,191	$25,295,017
Turpentine:		
Gallons	26,980,981	28,988,954
Value	$10,509,527	$12,654,228
Rosin:		
Barrels (280 pounds)	2,885,077	3,263,857
Value	$10,329,410	$12,576,721
Dross and other products, value	$151,254	$64,068

[1] In addition, in 1914, 92,401 gallons of turpentine, valued at $36,617, and 8,027 barrels of rosin, valued at $44,734, were reported by establishments assigned to lumber and timber products, and 575,557 gallons of turpentine, valued at $194,183, and 51,825 barrels of rosin, valued at $198,165, by wood distillation. In 1909, 18,310 gallons of turpentine, valued at $7,482, were reported by lumber manufacturers, and 706,868 gallons, valued at $249,526, by wood distillation. In 1904, 442,185 gallons of turpentine, valued at $176,521, were reported by wood distillation.

The total production of turpentine in all industries was 27,648,939 gallons valued at $10,740,327 in 1914, as compared with 29,714,132 gallons, valued at $12,911,236 in 1909.

The acreage of timber land worked in 1914 was 8,428,088, compared with 8,076,915 in 1909, making an increase of 4.6 per cent. The returns show a very great increase in the use of the cup system of gathering crude gum. In 1914 the number of crops (of 10,500 cups) worked was 11,813, as compared with only 2,383 in 1909, the percentage of increase being 395.7. On the other hand, the number of crops worked by the boxing system decreased from 17,775 in 1909 to 6,353 in 1914, or 64.3 per cent. The number of crops in back-boxed timber increased from 6,795 in 1909 to 8,314 in 1914, or by 22.4 per cent.

Wood Distillation, Not Including Turpentine and Rosin

This classification includes establishments engaged in the manufacture of wood alcohol (methyl alcohol), pyroligneous acid, acetates, tar, turpentine, and charcoal by the destructive distillation of wood in retorts, ovens, or kilns, but does not include establishments making spirits of turpentine from the crude turpentine or gum exuded by the southern pine. The statistics include establishments engaged in the refining of crude wood alcohol. In the North the hard woods are generally used with a production of wood alcohol, while in the South wood distillation is usually confined to pine with a production of turpentine.

The statistics for materials, products, and equipment, for 1914, in comparison with those for the census of 1909, are given in Table 122.